

Build Our 25-Foot Houseboat for \$1000 Page 158

POPULAR MECHANICS

JAN. 1969
50 CENTS

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Engine
Had it?
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**SPECIAL
MIDWINTER**

CAR ISSUE 36 Pages

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Comparing Those Sporty Small Sedans:

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Winter Driving Tips. How to keep going on icy turnpikes and mountain roads.
PM Owners Report on American Motors' AMX. Owners tell what's good and bad.

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JANUARY 1969

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LETTERS

TO THE EDITOR

Grizzly bear mystery

The article *Glacier Park's Grizzly Bear Mystery* (page 82, Nov. PM) seemed quite fair concerning the events and author E. D. Fales Jr. avoided some of the sensationalism of other writers.

Mr. Fales mentions the hope of having some kind of defensive protection for the people who hike in the back country of the national parks. Most people recognize that the national parks are for protection of the ecology and animal life and that human visitors are just that—visitors.

The Park Service has enforced an excellent policy to keep the back country clean as one means to avoid encounters with bears. But more is needed.

Friends of Glacier National Park has sought just such a chemical spray as Mr. Fales mentions. Possibly some reader might have some advice. If so, he may write Friends of Glacier National Park, Box 322, West Glacier, Mont. 59936.

WEST GLACIER, MONT. THOMAS R. BEST
PRESIDENT

I was shocked because people are not allowed to carry guns in our park system to defend themselves. In a free country people should have the right to protect themselves; a gun should be the right of any person leaving the tourist centers to backpack or hike into the interior of a park. The way to self-protection is not to exterminate the "enemy" (we must remember that a demented bear is the exception just as a demented person is), but to be allowed to defend yourself adequately. A gun is as basic a survival tool as matches for those who pack in.

MERRIMAC, WIS. LINDA VLAHOS

A recounting of these tragic events should not have been published out of consideration for the families of the girls who lost their lives. Reporting of the event by news media at the time it happened was sufficient. Surely if families or close friends have the misfortune to read the current story, it will renew grief which had perhaps begun to heal.

LEWISTON, N.Y. THOMAS E. GUENTER

No bargaining power

That book excerpt, *How to Bargain With a Car Dealer* (page 76, Nov. PM) was enlightening, but of little or no real help.

The whole article could have been nice-

ly summed up by stating the cold, hard fact that you can never beat the car dealer at his own game. He has a product you desire very much—and knows it. You can buy it only on his terms or not at all. The buyer has absolutely no bargaining power.

CHICAGO

KEN GREENBERG

Author Merle Dowd states a retail sticker price of \$3660 with a 25-percent markup would give a dealer a markup of \$915.

A new automobile that costs a dealer \$2928 from the factory with a 25-percent markup would have a list price of \$3660. The 25-percent markup would be \$732. You must take 20 percent of the retail price of an article with a 25-percent markup to arrive at the correct dealer's cost.

YOUNT FORD SALES

ROBERT YOUNT

BARRINGTON, ILL.

Strictly speaking, Mr. Yount is correct. The National Assn. of Automobile Dealers explains the semantics of the situation this way:

The dealer buys the car from the manufacturer at its retail (sticker) price, less a discount fixed by the manufacturer. The amount the dealer pays is the invoice price. Whatever the dealer sells the car for—above invoice price—is the markup.

Thus, if the dealer buys a \$4000 (sticker price) car from the manufacturer at a discount of 25 percent, he pays a \$3000 invoice price. If he sells it to you at a markup of 25 percent, the price is \$3750.

(There are, of course, other cost factors—such as shipping—that the dealer has to pay and pass on to the buyer.)

Lightweight is load-bearing

With the article *How to Lay Concrete Blocks Like an Amateur* (page 166, Oct. PM) you printed *A Thumbnail Guide to Concrete Blocks* (page 171) in which you made the statement: "Never use lightweight blocks for load-bearing walls."

This is a blatant misstatement of fact. Not only is it possible to use lightweight block for load-bearing walls, the majority of walls built for load-bearing masonry construction—even in those areas subject to the severe stresses of earthquakes—are built of lightweight blocks.

An example of load-bearing masonry is the Sportsmen's Lodge Hotel, built several years ago in North Hollywood. Another

(Please turn to page 8)

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AS YOU LEARN, YOU JUST SLIP INTO THE IMMENSE FLOW OF UPHOLSTERY WORK! Think of all there is!... Sofas, lounging chairs finished in beautiful fabrics, which MUI tells you how to get at the right price — even leather and all the new vinyls. And then you have built-ins and breakfast nooks, boats, trailers and all the millions of automobiles in America. Yes, you learn all this and more! When we finish teaching you, (in your own home in your spare time) and when you get our California state approved diploma, you **know** this business... as a **real professional!** You will then have one of the most fantastic moneymaking skills in America built into your head and hands! No one can ever take this skill away from you... and no one can ever fire you, because **you're the boss** of a business that you can take with you... You can make big money from then on... any time, anyplace you want to put out your shingle!

When you read the papers you see there's a strike here, a lockout there. Detroit lays off 150,000 men. A plant is shut down and moved out of state. A new automated machine eliminates 5,000 jobs. They talk about dislocated workers and try to do something about it. What pays the bills if you get caught up in one of these situations? When you know upholstering, life gets very simple and lots of fun. It's simple because where there are people, there are upholstery jobs and lots of them. It's fun because life is fun when the bills are paid and there's money in the bank, even enough to buy those things you've always wanted for yourself.

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Lights easy—
takes its own
good time about burning.

LETTERS

(Continued from page 6)

larger example is the eight-story Hanalei Hotel addition in San Diego. An even more striking example is the 13-story Catamaran Motor Hotel in San Diego.

If lightweight concrete blocks are used in such critical load-bearing structures, they would certainly be adequate for whatever use might be made of your recommendations.

LOS ANGELES

WALTER L. DICKEY
CONSULTING STRUCTURAL ENGINEER

There is no technical foundation for your statement. The American Society for Testing and Materials has specifications for lightweight aggregates for concrete masonry units as well as specifications for load-bearing concrete masonry units. Units made with aggregates of our members always exceed the 1000 p.s.i. minimum compressive strength requirements (gross area) stipulated for load-bearing units.

EXPANDED SHALE CLAY FRANK G. FRSKINE
AND SLATE INST. MANAGING DIRECTOR
WASHINGTON, D.C.

Responds author Richard Day: "I am wrong, wrong, wrong. I don't know where the statement came from.

"Henry Toennies, director of engineering of the National Concrete Masonry Assn., says: 'Absolutely no difference is made in the use of lightweight-aggregate concrete masonry units and the units made with normal or heavyweight materials.'"

Why the New Jersey?

After reading *A Battlegewagon Returns From Mothballs* (page 88, Oct. PM), I have two questions:

Why was the *New Jersey* chosen as opposed to one of her other three sister ships—specifically the more famous *Missouri*?


Where does author Bob Zimmerman get the 58,000-ton figure he quotes in the article? As I remember, the *Iowa*-class battleships were officially rated at 45,000 tons displacement.

PITTSBURGH, PA.

W. J. KOPP

"The main consideration in choosing the *New Jersey* for reactivation instead of one of the others was the time and investment needed to get it back in shape," writes Mr. Zimmerman. "There was more stainless steel used in the construction of the *New Jersey* than in the other three, and therefore it had weathered its years

(Please turn to page 10)

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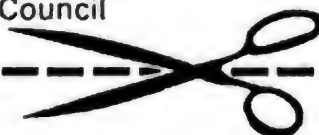
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LETTERS

(Continued from page 8)

in storage in better shape. Also, the New Jersey had been in active service more recently than the others, and having spent less time in mothballs it needed less refurbishing.

"Mr. Kopp is correct in that the Iowa-class battleships have an official 'standard displacement' rating of 45,000 tons. The 58,000-ton figure is the New Jersey's full-load displacement—carrying fuel, ammunition, stores, and so on. Neither figure is any more accurate than the other, as long as you understand what type of displacement you mean. Jane's Fighting Ships and other directories usually list both."

Doesn't feel sorry

The police forgot to fine A. R. Roalman for driving with a broken speedometer ('Grounded' for 90 Days, page 61, Nov. PM). With a broken speedometer, he could have been going 20 mph over the speed limit.

Your windshield wipers, speedometer, horn, lights, brakes, and so on are to be in working order at all times. Driving with his speedometer broken was a violation in itself. I don't feel sorry for this man.

BINGHAMTON, N.Y. ANTHONY J. MILDICE

We suspect that after three months afoot, Mr. Roalman has the best-maintained and most law-abiding car on the block. However, he writes so well that we're trying to get him into some other trouble with the police.

'Turned on' about houseboats

We Took a Houseboat Vacation (page 100, Nov. PM) by John Linkletter has "turned us on." Now supply us with the "stuff." The article has us wanting to rent a boat for a vacation as soon as possible.

Where can we find out who rents houseboats and where? Is there a directory or other source of information?

MOUNTAINSIDE, N.J. ERNEST SCHMID

There's no national association of houseboat renters, thus no "official" list. The most complete list we've seen is the Coast-to-Coast Houseboat Rental Directory published by Family Houseboating, P.O. Box 2081, Toluca Lake, Calif. 91602. Send them 50 cents and your name and address for a copy.

There's also a special houseboat section (including rental list) in the Dec. 1967 issue of Sports Afield that a neophyte would find extremely valuable. Look in your local library.

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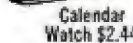
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First for Japan

The *Shinkai*, Japan's first bathyscaph, can submerge to a depth of 1980 feet, carrying a crew of four. It'll be used for research.



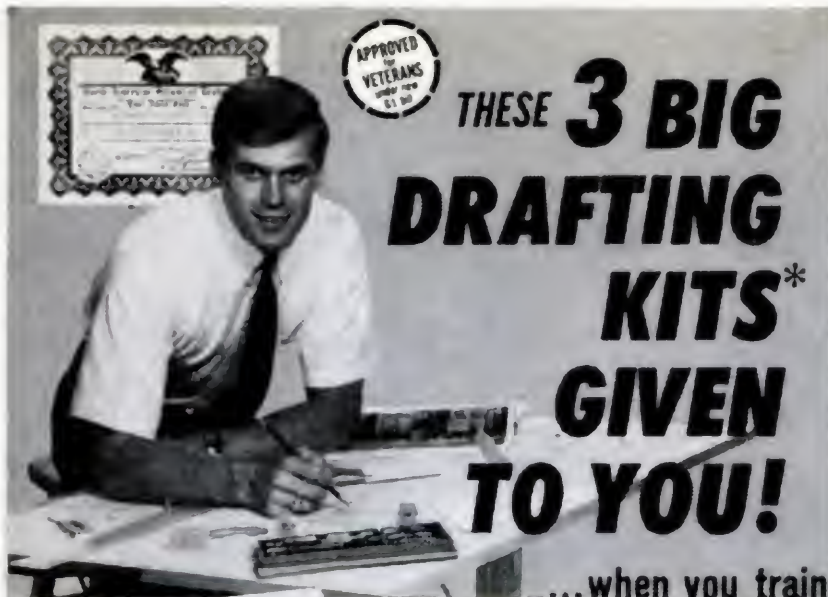
Haircut, too?

Gillette researchers in Reading, England, come to work unshaven so the "Scaffold" can shave one square inch of skin and record the pressure required in shaving.



Giant mirror

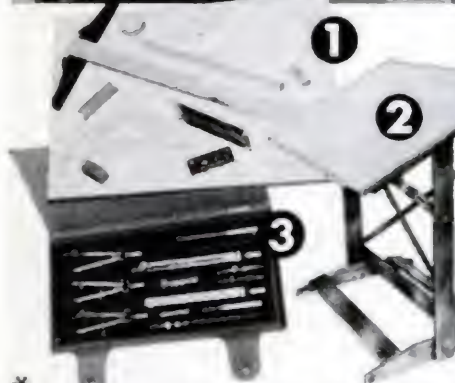
A 20-foot magnesium mirror, built by GE for NASA, is coated with metallized aluminum that was evaporated off tungsten metallizing filaments in a vacuum chamber.



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U. S. LABOR DEPT. REPORTS SERIOUS SHORTAGE OF DRAFTSMEN

(The following quotes from U. S. Labor Dept. point out nationwide shortage for Draftsmen.)

"The dearth of qualified applicants has resulted in increasing calls for trainees, as employers in many areas relaxed hiring specifications. Experience requirements have been virtually eliminated, along with age barriers."

"Steadily growing employer requirements...were accompanied by marked reductions in the supply of draftsmen available."

TOP AMERICAN EMPLOYERS WELCOME NASD GRADUATES

"We would be interested in interviewing your grads as potential employees." REMINGTON

"At the present time we have several openings available for qualified Draftsmen. I look forward to considering graduates of your institution." WESTINGHOUSE

"We have immediate openings for designers and Draftsmen and have a definite interest in interviewing candidates immediately."

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\$400-\$1200 PER YEAR NO EXPERIENCE

Trained and experienced from a basic, but not an advanced, employment level course.

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① Architectural Drafting

Today's population explosion guarantees boom in building of homes, churches, schools, factories, office buildings & warehouses is just starting. Thousands Architectural Draftsmen needed NOW because drawings must be made of every part of every building before ground can be broken.

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Skyrocketing U.S. mass production requires millions of drawings & thousands of Mechanical Draftsmen all along the way. Drawings must be made of every PART of every product used in the U. S. (as well as of the machines that make these parts) before production can be started.

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Earns \$820 Month!

"My first position after completing your course jumped my income from \$350 to \$820 per month." —G. W., Tenn.

Big Promotion!

"I was promoted from the production line ahead of 4 others and got a good pay raise." —W. A., Wisc.

Gets 50% Raise!

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I'd like to give this to my fellow men...

while I am still able to help!

I was young once, as you may be—today I am older. Not too old to enjoy the fruits of my work, but older in the sense of being wiser. And once I was poor, desperately poor. Today almost any man can stretch his income to make ends meet. Today, there are few who hunger for bread and shelter. But in my youth I knew the pinch of poverty; the emptiness of hunger; the cold stare of the creditor who would not take excuses for money. Today, all that is past. And behind my city house, my

summer home, my Cadillacs, my winter-long vacations and my sense of independence—behind all the wealth of cash and deep inner satisfaction that I enjoy—there is one simple secret. It is this secret that I would like to impart to you. If you are satisfied with a humdrum life of service to another master, turn this page now—read no more. If you are interested in a fuller life, free from bosses, free from worries, free from fears, read further. This message may be meant for you.

By Victor B. Mason

I am printing my message in a magazine. It may come to the attention of thousands of eyes. But of all those thousands, only a few will have the vision to understand. Many may read; but of a thousand only you may have the intuition, the sensitivity, to understand that what I am writing may be intended for you—may be the tide that shapes your destiny, which, taken at the crest, carries you to levels of independence beyond the dreams of avarice.

Don't misunderstand me. There is no mysticism in this. I am not speaking of occult things, of innumerable laws of nature that will sweep you to success without effort on your part. That sort of talk is *rubbish*! And anyone who tries to tell you that you can *think* your way to riches without effort is a false friend. I am too much of a realist for that. And I hope you are.

I hope you are the kind of man—if you have read this far—who knows that anything worthwhile has to be *earned*! I hope you have learned that there is no reward without effort. If you have learned this, then you may be ready to take the next step in the development of your karma—you may be ready to learn and use the secret I have to impart.

I Have All The Money I Need

In my own life I have gone beyond the need of money. I have it. I have gone beyond the need of gain. I have two businesses that pay me an income well above any amount I have need for. And, in addition, I have the satisfaction—the deep satisfaction—of knowing that I have put more than three hundred other men in businesses of their own. Since I have no need for money, the greatest satisfaction I get from life is sharing my secret of personal independence with others—seeing them achieve the same heights of happiness that have come into my own life.

Please don't misunderstand this statement. I am not a philanthropist. I believe that charity is something that no proud man will accept. I have never seen a man who was worth his salt who would accept something for nothing. I have never met a highly successful man whom the world respected who did not sacrifice something to

gain his position. And, unless you are willing to make at least half the effort, I'm not interested in giving you a "leg up" to the achievement of your goal. Frankly, I'm going to charge you something for the secret I give you. Not a lot—but enough to make me believe that you are a little above the fellows who merely "wish" for success and are not willing to sacrifice something to get it.

A Fascinating and Peculiar Business

I have a business that is peculiar—one of my businesses. The unusual thing about it is that it is needed in every little community throughout this country. But it is a business that will never be invaded by the "big fellows." It has to be handled on a local basis. No giant octopus can ever gobble up the whole thing. No big combine is ever going to destroy it. It is essentially a "one man" business that can be operated without outside help. It is a business that is good summer and winter. It is a business that is growing each year. And, it is a business that can be started on an investment so small that it is within the reach of anyone who has a television set. But it has nothing to do with television.

This business has another peculiarity. It can be started at home in spare time. No risk to present job. No risk to present income. And no need to let anyone else know you are "on your own." It can be run as a spare time business for extra money. Or, as it grows to the point where it is paying more than your present salary, it can be expanded into a full time business—overnight. It can give you a sense of personal independence that will free you forever from the fear of lay-off, loss of job, depressions, or economic reverses.

Are You Mechanically Inclined?

While the operation of this business is partly automatic, it won't run itself. If you are to use it as a stepping stone to independence, you must be able to work with your hands, use such tools as hammer and screw driver, and enjoy getting into a pair of blue jeans and rolling up your sleeves. But two hours a day of manual work will keep your "factory" running 24 hours turning out a product that has a steady and

ready sale in every community. A half dollar spent for raw materials can bring you six dollars in cash—six times a day.

In this message I'm not going to try to tell you the entire story. There is not enough space on this page. And, I am not going to ask you to spend a penny now to learn the secret. I'll send you all the information, free. If you are interested in becoming independent, in becoming your own boss, in knowing the sweet fruits of success as I know them, send me your name. That's all. Just your name. I won't ask you for a penny. I'll send you all the information about one of the most fascinating businesses you can imagine. With these facts, you will make your own investigation. You will check up on conditions in your neighborhood. You will weigh and analyze the whole proposition. Then, and then only, if you decide to take the next step, I'll allow you to invest \$15.00. And even then, if you decide that your fifteen dollars has been badly invested I'll return it to you. Don't hesitate to send your name. I have no salesmen. I will merely write you a long letter and send you complete facts about the business I have found to be so successful. After that, you make the decisions.

Does Happiness Hang on Your Decision?

Don't put this off. It may be a coincidence that you are reading these words right now. Or, it may be a matter that is more deeply connected with your destiny than either of us can say. There is only one thing certain: If you have read this far you are interested in the kind of independence I enjoy. And if that is true, then you must take the next step. No coupon on this advertisement. If you don't think enough of your future happiness and prosperity to write your name on a postcard and mail it to me, forget the whole thing. But if you think there is a destiny that shapes men's lives, send your name now. What I send you may convince you of the truth of this proverb. And what I send you will not cost a penny, now or at any other time.

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DWELL TACHOMETER

ASSURE: EASY STARTS, OPTIMUM PERFORMANCE and
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MADE ORIGINALLY FOR THE PROFESSIONAL AUTOMOTIVE TECHNICIAN, MODEL BT-162 WILL
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*The Model BT-162 will perform the services specified below
in addition to many other tasks too numerous to mention:*

- ✓ Assure precise adjustment of points that are slightly worn or pitted.
- ✓ Indicate the most effective point setting without removing the distributor cap.
- ✓ Read the average dwell of dual breaker points as well as individual dwell of each individual set of points.
- ✓ Indicate the correct settings for external adjustment type distributors.
- ✓ Car manufacturers' dwell angle recommendations are included in the manual provided with the Model BT-162 for all cars including the external adjustment type distributors specified above.
- ✓ It is no longer necessary to file points to smoothness when using the Model BT-162. The instrument will automatically make allowance for any existing "pitting" or "wear."
- ✓ To adjust for mathematically correct carburetor adjustment and thus insure maximum gas economy and quiet engine running, simply use the Tachometer section of the Model BT-162. Read the exact RPM while the engine is in neutral position. Then adjust the carburetor in conformity with the car manufacturer's recommendations as specified in the manual provided with the Model BT-162.
- ✓ To locate a "miss" you need only disconnect or "short" the spark plugs one at a time with the Model BT-162 switched to the Tachometer position. You will be able to instantly identify which particular plug (or frequently its wire lead) is responsible for the malfunction.
- ✓ Cars with automatic transmissions function efficiently only if the fluid pressures are correctly maintained and since manufacturer's instructions always refer to RPM the Model BT-162 (or an equivalent tachometer) is required to properly service automatic transmissions. Incidentally, the 5,000 RPM maximum range of the Model BT-162 is adequate for all car engines without any exceptions.

Comes complete, ready to use. Operating manual includes manufacturer's dwell angle recommendations for all cars. The manual is yours to keep even if you decide to return the instrument.

\$29⁹⁵

SEND NO MONEY WITH ORDER
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Try it for 10 days before you buy. If completely satisfied then send \$5.00 and pay the balance at the rate of \$5.00 per month until the total price of \$29.95 (plus P.P., handling and budget charge) is paid. If not completely satisfied, return to us, no explanation necessary.

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You must be fully satisfied. If not, return in 10 days, freight collect. Money promptly refunded in full.

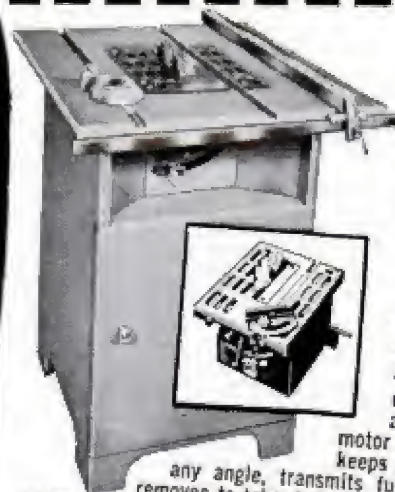
ENDORSED BY AMERICA'S TOP MAGAZINES... Here is what the editors say:

"A good bit of sound—imaginative—engineering." Popular Science; "(saw) boasts many features of bigger brothers." Popular Mechanics; "Amazingly versatile." Workbench; "Highly substantial construction, sturdy enough for production line use."

Industrial Woodworking. And Workbench awarded these tools their coveted "Work Tested" Seal.

OVER A MILLION USERS confirm their precision, versatility and rugged performance.

***10-YEAR FULL SERVICE GUARANTEE...** Any part or parts of any AMCO power tool (except motor) which may become inoperative for any reason within ten years after the purchase date will be repaired or replaced by the factory without cost to the purchaser. Your only cost: for postage.



8" TILT ARBOR POWER SAW

DOES WORK OF \$75 BENCH SAW as is. Converts easily to equal any \$300 floor model cabinet units! Crossovers, rips, mitres, cuts compound angles, dados, makes coves and mouldings.

\$14.95 f.o.b. factory. Wt. 25 lbs. Includes completely assembled cast iron and steel 8" saw with ground cast iron table... less blade. **RIP FENCE**, if desired, for easier work alignment, \$3.50 add'l.

SAW BLADE TILTS... TABLE STAYS LEVEL

Locks securely at any angle up to 50°, raises, lowers 0"-2 1/4". Patented tilt mechanism, accurate etched scale. Patented motor mount takes std. 1/4 h.p. or larger motor, keeps belt tight, assures perfect alignment at any angle, transmits full power. Takes std. blade, saw insert removes to take dadoe heads, cutters, etc. (not incl.). Accurate mitre gauge assembly. Ground spindle. Enclosed steel base. "Compo" bearings. Access. Std. size (for bench saw) \$3.50; larger fence (for cabinet base, as ill'd.) \$4.50.

FREE CABINET BASE PLANS Use as portable bench saw as received (inset photo) work of floor models costing \$300. **FREE plans...** all you'll need are a sheet of 3/4" plywood and 3-4 hours. Use your AMCO saw for cutting. Plans provide 27" x 24" work surface, 33" height, tool storage compartment.

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6" SWING 3-FOOT LATHE



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Set of 3 high speed turning chisels, \$4.95 add'l.

DOES THE WORK OF \$40 UNITS... with same precision and speed. Turns wood, plastic. Sturdy cast iron with tubular steel bed. Ball thrust cup center, spur center, T-rest assembly, lever action tail stock, 2-speed pulley. Fits any motor.

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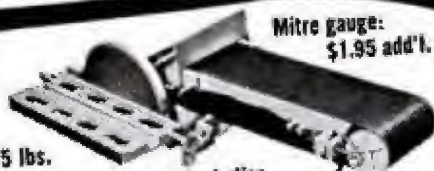
PRECISION 4" x 36" BELT SANDER

f.o.b. factory. Wt. 15 lbs.

\$14.95 Disc Sander attachment incl. disc bracket, ground cast table (tilts 0-45°): \$7.95 add'l.

DOES WORK OF \$50 SANDERS... The world's most talented belt sander. Heavy cast sander incl. 4" x 36" sanding belt, V-pulley drive, multi-purpose drive spindle. Changes from horizontal to vertical sanding in secs. Uses 1/2 hp or larger motor.

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Mitre gage: \$1.95 add'l.

FULL 22" LONG, 4 1/8" JOINTER-PLANER

\$19.95

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100% precision ground cast iron and steel.

DOES THE WORK OF \$60 UNITS... Professional power planing at a hand tool price. Make faster, more accurate joints, rabbetts, bevels for windows, doors, drawers, square tapered legs—Adjustable precision ground cast iron tables. Patent-pending design holds knife to table clearances at any depth. Rabbett depth 3/8". Fence adjustable 0°-50°. Hardened, ground hi-speed steel knives. Dual cutter guards. Balanced cutter head.

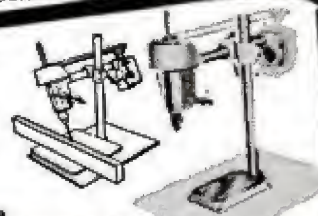
10-YEAR FULL SERVICE GUARANTEE*

32" RADIAL DRILL PRESS

All cast iron and steel

f.o.b. factory **\$29.95** Wt. 30 lbs.

1/2" cap. Jacob's chuck incl.



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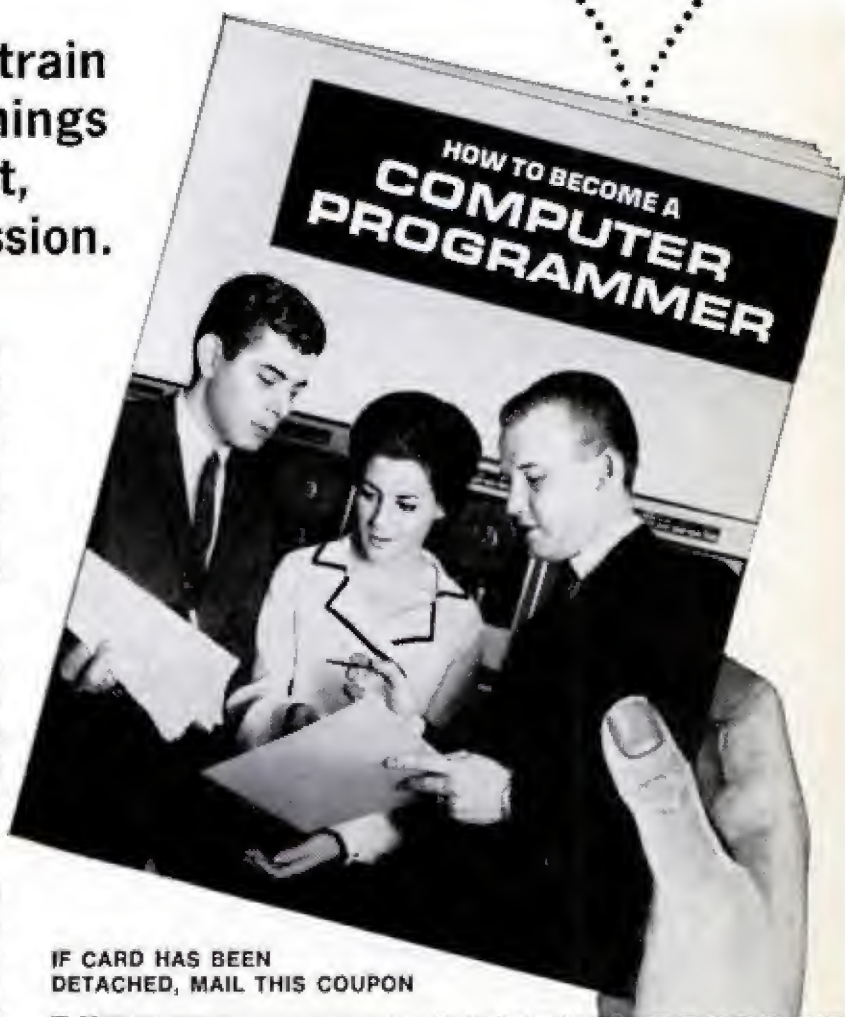
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A flexible contact lens, more comfortable than the hard plastic lenses now in use, has been developed by Bausch & Lomb, Inc. Because of its softness, the new lens conforms to the curvature of the eye and rarely pops out, a characteristic that should recommend it to athletes. The lens is made of hydroxyethyl methacrylate, a water-absorbent material that becomes soft when wet.

Voyages to nearby stars will be possible 200 years from now, according to Prof. Freeman Dyson of the Institute for Advanced Study in Princeton, N.J. Method of propulsion may be the fusion reaction that takes place in hydrogen bombs. Chemical rockets, says Prof. Dyson, have just about reached their practical limit. Their ratio of take-off weight to final "flying" weight is too high. But a fusion rocket could carry a payload that would be a reasonable fraction of its total weight. Since the nearest neighboring star is 4.3 light-years away, the trip would take several centuries. It would be necessary to send colonies of people rather than individuals.

Which pig or steer to slaughter for its lean meat? A new device—an ultrasonic animal scanner—makes it easy to tell. The scanner shoots ultra-high-frequency sound signals into an animal and then picks up the echoes from layers of fat and muscle, which differ in density. The echoes show up on an oscilloscope as blips of light. The blips are recorded on film to produce a composite picture of the animal's tissues. The device was developed by Dr. James R. Stouffer of the New York State College of Agriculture at Cornell University. One valuable use: to pick out animals for breeding that have particularly good meat characteristics.

The job of reassembling 30,000 pieces of an ancient Egyptian temple at Karnak is being given an assist by an IBM computer. Fortunately, each piece is decorated with scenes and hieroglyphic inscriptions, giving archeologists clues to work with. The pieces are coded and photographed, and the photos matched with the help of the computer. The temple was devoted to Aten, the sun god, and was built during a period of monotheism. But it was destroyed in about 1350 B.C. when a new pharaoh re-established polytheism. Its blocks were scattered and used as fill for new buildings.

Insomniacs can be helped by electrosleep treatments. That report comes from Israel's Hadassah-Hebrew University Medical Center where physicians have treated patients suffering from chronic insomnia by passing a mild electrical current through the brain. After 10 to 20 such treatments, 15 out of 20 patients regained normal sleeping habits, which they continue to maintain a year later. All patients were resistant to conventional therapies and most were addicted to sleeping pills. Though electrosleep has not gained much scientific attention in the United States, it is said to be used in the Soviet Union.

Newly announced plans by NASA call for the construction of an X-ray spectrographic telescope that will fly in the 1970s as part of a "giant Apollo telescope mount which is to be attached to a spent Saturn rocket stage." The spent stage, according to NASA, will be converted into a space workshop in which men will stay for prolonged periods and perform various experiments. The spectrographic telescope will be used to accumulate data on X-ray emissions from the quiet and active regions of the sun.

Electricity-producing fuel cells for use in the home, factory and office will be available within a year, according to a spokesman for the American Gas Assn. The fuel cells will combine natural gas and air electrochemically to produce energy that should be competitive in price with conventionally generated electricity within two or three years. The fuel cells probably will be leased to users.

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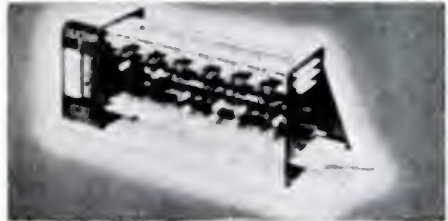
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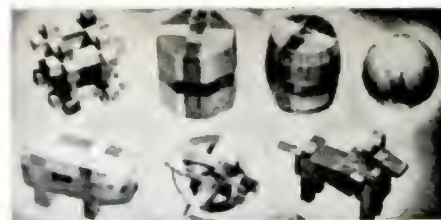
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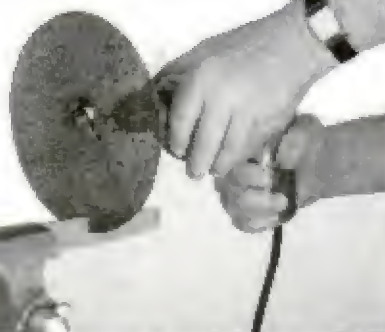
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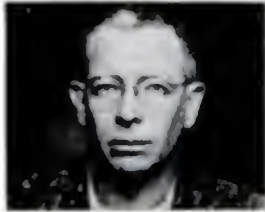
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BY BILL KILPATRICK

FORD WILL OFFER TWO SUBCOMPACTS, first a Ford, to be followed by a similar—but presumably plusher—car to be sold by Lincoln-Mercury dealers. The Ford version is due to be introduced in another few months, the Mercury not 'til fall, possibly even later. The subcompact concept at Ford started out as a strictly bread 'n' butter affair aimed at grabbing off a little (or a lot!) of VW-type business. But now Dearborn is said to be fiddling with vinyl roofs, sporty trim options . . . even a hop-up kit. It figures. An affluent buying market wants cars that reflect its affluence, particularly when it comes to domestics. The imports have going for them a sort of "mystique" that plainly indicates their buyers have exercised an "informed" freedom of choice. But when it comes to "Made in U.S.A." cars, American buyers want candy and more candy. Catering to this desire on one hand, and holding the price below (or very near) \$2000 on the other, is going to be the big hurdle for all the new subcompacts.

CAR REPAIR COSTS are being probed by the Senate's Anti-Trust and Monopoly Subcommittee. Under the chairmanship of Sen. Philip A. Hart (D., Mich.), the subcommittee is reportedly anxious to learn why repair parts and labor costs have risen over 50 percent in less than 10 years. This one could be a beaut, could be a prime mover in needed overhaul of the entire service/repair business. Under the subcommittee gun? Auto manufacturers, who will be urged to make more of their products more repairable, and the many middlemen—wholesalers, jobbers, distributors and so on—between a part and its ultimate consumer. Also scheduled for Senate scrutiny are current flat-rate manuals, the thought being they're an unsatisfactory means of determining labor repair-cost guidelines.

CHEVROLET WILL DROP the Corvair name when the car goes out of production at the end of the current model year. Some industry observers thought GM might dub its new subcompact—due as a 1971 model—a Corvair, but the auto giant is said to feel the name is a loser, mostly as a result of the present car's well-publicized troubles in court. The car has been soft-pedaled by Chevy the past three years, was offered in the '69 line as a sop to GM's pride. Sales of '68 Corvairs were down 50 percent from '67 (in peak year '61, sales topped 300,000), are down even more so far in the '69 model year. Car wasn't exactly a standout when introduced, has since been evolved into a trim, nimble package worthy of more buyer attention than it gets. But "the word" is out, and that's that. The name being bandied about for the new subcompact is Chevette.

CONVENTIONAL SNOW TIRES provide only a small improvement in pulling power over regular tires, a study by the National Safety Council's Committee on Winter Driving Hazards indicates. In tests conducted on glare ice at Stevens Point, Wis., the committee determined that conventional snow tires improve pulling power only 28 percent. Used studded snow tires are reported as being 183 percent better in pulling power than regular tires, new studs over 218 percent better. Best of all, the committee reports, are reinforced tire chains, said to improve pulling power over 600 percent.

SAFETY CRITICS are quietly mustering forces for an all-out attack this year on so-called "performance" cars. They aren't as unhappy with the cars per se as they are with the way they're promoted. Specifically, the attack will be focused on "hot car" ads pointedly aimed at youngsters—ads that stress speed, imply that aggressive cars, driving are "in." Supposedly shocked at plethora of muscle-car promotion, self-appointed consumer champion Ralph Nader—no stranger here—has said he plans to squawk long and loud before the President's National Commission on Causes and

(Please turn to page 26)

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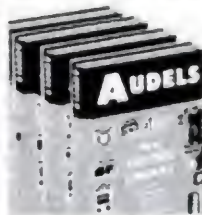
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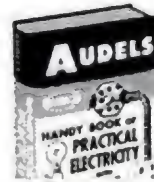
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DETROIT LISTENING POST

(Continued from page 24)

Prevention of Violence, says he wants the commission to take into account "the emphasis by the auto industry on aggression, power and speed in selling a product involved in the deaths of 53,000 people a year." Industry, which cooled the horsepower race slightly over the past three years, counters that it has to pour it on to attract young buyers, remain competitive. "If we don't peddle performance," one highly placed auto man told DLP privately, "the competition will. It's what the kids want and are buying."

WORKING UP STEAM is inventor/industrialist William P. Lear, who recently announced he's working on a "complete automotive system" built around what he describes as a "small, reliable" steam engine utilizing space-age technology and materials. Lear says his new engine will fire up in 20 seconds or less in temperatures as low as minus 20° F., will get 20-22 miles to a gallon of kerosene while powering a 4000-lb. car 60 mph, will be the basis of a business that in three years will grow to annual sales of \$150 million. Lear also said he'll deliver ten steam-driven busses to "a major American city" this spring, that he plans to build two steam race cars for this year's Indianapolis 500. Founder of Lear Jet Industries and Lear, Inc., he holds more than 100 aviation and electronic product patents, has an impressive business record, also has cash, facilities and enthusiasm to give his steam-car project a good run.



OFF ON A NEW JAG is newly-formed British Leyland Motors with the recent introduction in the United States of the Jaguar XJ Luxury Sedan. Tagged at just under \$6500 (East Coast P.O.E.), new car features four-wheel disc brakes, four-wheel independent suspension, manual or automatic transmissions and Jag's by-now-traditional 246-hp, 4.2-liter Six, said to be capable of moving things along at 127 mph maximum. Car is a very comfortable, posh four-seater (five in a literal pinch); replaces the Jaguar 420. ★ ★ ★

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Those electrical gadgets you have around your house are great on convenience, but if you're like a lot of do-it-tomorrow Johnnies, you don't know where to turn when one breaks down. So you call one of the busy Appliance Servicemen in your town, then drink instant until that fancy automatic coffee pot is perking again.

People have so many electrical appliances, it's no wonder Appliance Repairmen are busy as a bee in a bee nest. Count yours. The average home has at least a dozen, maybe more. There are better than 800 million appliances in the U.S.A. right now. No wonder the man who knows how to service appliances properly is pocketing \$4 to \$6 an hour, for as many hours as he cares to work!

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WHAT'S NEW OUTDOORS

BY DAN FALES

CLOSING TO THE PUBLIC some areas in our national parks and limiting visitor hours in other areas can only be termed a tragedy.

Last year, Congress ordered manpower restrictions within the National Park Service. This order means that NPS can no longer give total service to the 270 areas under its jurisdiction.

This may not sound like much, but the urbanization of our society means that the people have to "get outside more." This need is becoming a necessity. "Getting out" can no longer be called a luxury.

This fact is obvious when park visitation figures are cited. In the past five years, there's been a 48 percent increase in the number of visits to our national parks—from 103 million in 1963 to an expected 152 million in 1968! During this period, too, management responsibilities for 46 new areas were added to NPS. With only a 13 percent rise in NPS manpower, it's not hard to see the problem.

Now Congress steps in and says that NPS must cut back from 7575 employees to the June 30, 1966, level of 5998. That's going the wrong way.

NPS has never been at full strength, but at least it had hold of the situation. If this year's Congress doesn't reverse the decision of last year's group, you'll see restricted use of our public lands.

This doesn't mean that the 90th Congress was all bad. Passed late in the session were bills creating the Redwood National Park, the North Cascades Park, Scenic Rivers and the Great Swamps National Wildlife Refuge.

A SNOWMOBILE SERVICE MANUAL is now on the market. This 144-page book gives a complete rundown on 22 makes of snowmobiles.

There's also a section on engines which covers 30 models including the new two-cycle Kohler, Yamaha, Chrysler 820 series and the Wankel rotating combustion engine. Full explanations of engine design and principles are included in the manual.

There are sec-

tions on transmissions and tracks. The book is available for \$5 from J. C. Whitney & Co., 1917 Archer Ave., Dept. 406, Chicago, Ill. 60616.

A KIT to help your car's transmission keep its cool is available for those who use their cars to pull heavy trailers.

Towing travel trailers or heavy boats on trailers can cause additional heat-con-



trol problems which the towing car's factory-installed cooling system is not designed to cope with.

According to automotive engineers, the normal temperature of transmission oil ranges from 200° to 280° F. Under load, the temperature can go to 350°. Transmission oil begins to break down at 200° and deteriorates faster as temperature rises.

With excessive heat, shifting becomes sloppy and transmission seals begin to bake out and leak.

The Hayden Trans-Cooler, developed by Valley Tow-Rite, is a kit that you can install. It bypasses the car's factory-installed cooler or it can be installed in parallel to the factory system.

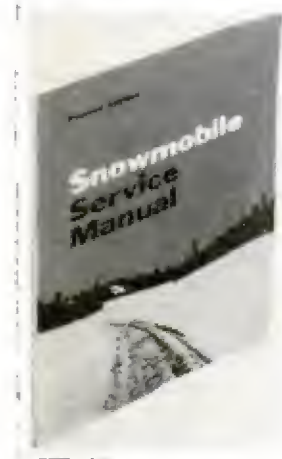
The kit consists of hoses, hose clamps, fittings, brackets for mounting the unit and installation instructions.

It takes about half an hour to rig. The installation can be removed at will, and the original factory system reconnected.

It costs about \$30 for a unit that will provide effective transmission cooling for trailer loads up to 2000 pounds. For more information, contact Valley Tow-Rite, Inc., 27 E. Vine St., Lodi, Calif. 95241.

IN ONE YEAR, 8¼ million saltwater fishermen caught 737 million fish weighing 1.47 billion pounds. That's no fish story.

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Drivin' with Dan

How do you measure engine displacement? Is four-wheel drive safer than two-wheel drive? What would happen to racing if the big companies pulled out? Dan Gurney answers these and other provocative questions



DAN GURNEY leads Jack McCoy through turn during last year's Riverside 500-mile stock-car race. This month Dan'll be seeking his sixth Riverside 500 win

Q. When you were starting your racing career, how much "rough stuff" were you subjected to on the track by older, more established drivers?
—Clint Beatty, Albany, N. Y.

A. That is a very good question. "Rough stuff" is cloaked in different clothing on different circuits. Things that would be considered rough stuff on a half-mile dirt track in a stock car would be suicide at Daytona. Things that would be considered rough stuff at Daytona in a stock car would again be suicide in an Indy car on the same track. Rough stuff in an open-wheel Grand Prix car would be child's play in a stock car or a trans-Am car on a road circuit. There is always a certain amount of testing of one's courage or spirit even among established drivers. As a rule I found the best drivers on road circuits were those who engaged in rough stuff the least. The beginning driver usually is tested by the rough-stuff drivers until they find out where each stands. Each driver has a "track personality" and the "pecking order" must be established. I doubt if I received any more rough stuff in the beginning than I have since.

Q. In measuring engine displacement, is the combustion chamber included, or only the cylinder area from the top of the block to the top of the piston at the bottom point in its stroke?—Cyrus Hayes, Erie, Pa.

A. Engine displacement concerns only the bore, stroke and number of cylinders. The combustion chamber volume at top dead center is what governs the compression ratio, not the displacement.

Q. Do you think four-wheel drive is safer than two-wheel drive? If so, what was USAC's reason for outlawing it?—David Kronoshek, Indianapolis.

A. No, I don't. There are more things to break in a four-wheel-drive car. On the other hand they seem faster under slippery conditions. I think USAC was concerned about the expense of racing. It is very difficult to find enough money to purchase and operate an Indy car these days. It takes over \$100,000 to be serious about going to the Indy 500.

Q. What would happen if the big car, tire and sparkplug companies pulled out of big-time racing? Where would that leave you, for example?
—Harold Johnson, Baton Rouge, La.

A. It would be a severe blow. However, I think that one or two would sneak back in when the others weren't looking, because it is a great way to sell a product. The performance image is important to the man on the street.

Q. Now and then, we read or hear of a "stuck throttle" causing a race accident. Why does this happen?—Elwood Abernathy, Des Moines.

A. It sounds ridiculous, but racing seems to bring out failures like this. Stresses on all the
(Please turn to page 34)



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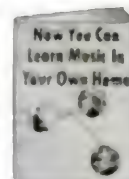
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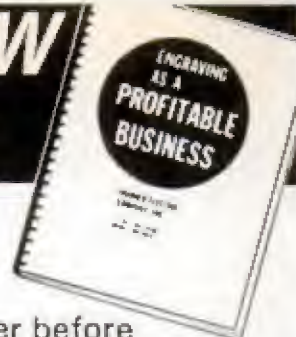
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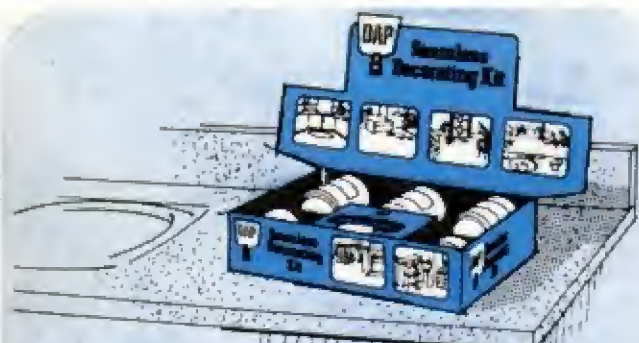
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DRIVIN' WITH DAN

(Continued from page 30)

linkages are much more severe than one would imagine. If you were to take an absolutely standard automobile and race it, all sorts of silly and dangerous things would happen. A stuck throttle still boils down to poor engineering and maintenance.

Q. *Why is the color green never used on American race cars, or even seen around racetracks?—Willard Moraghan, El Paso, Tex.*

A. It is an old superstition, but there are many exceptions these days. I really don't know how it started in the United States, but, on the other hand, I don't know how 13 was chosen as an unlucky number either. Peanuts in the shell are also taboo around USAC races. On the world scene, of course, the English have British Racing Green as their national color and they manage to get by.

Q. *Why don't you drive in more stock-car races?—Jay Hanigan, Mountainside, N.J.*

A. Because I am primarily a road racer. Stock cars race mostly on ovals. There are only 52 weekends per year, and most stock-car race schedules conflict with my other commitments.

Q. *I read where Lincoln-Mercury is seriously considering a power effort with you in next year's Can-Am series. Is this so?—James Gilmore, Santa Barbara, Calif.*

A. So far, Lincoln-Mercury has helped me with engine parts for the Can-Am series.

Q. *After a car has become obsolete, especially one very specialized like a Group 7 or Formula 1, what is done with it?—Jim Martin, Cincinnati.*

A. Most such cars usually are gobbled up quickly by the swelling ranks of amateur racers. Others are turned into show cars, cannibalized and converted to up-to-date versions, go to museums, or just rust in junk piles.

Q. *I hear you're getting out of Formula 1. Is it true?—Jerry Matthews, Sarasota, Fla.*

A. Yes, it is. We've taken a long, hard look at the entire F1 picture as it pertains to All-American Racers and have decided to abandon ship. F1 racing, particularly in the development of a competitive car, is becoming in-

creasingly expensive. Needed sponsor support is dwindling and I just don't see how we can hack it financially any longer. So, regretfully, we're pulling out. Personally, I have no definite F1 plans for the coming season.

Q. *Why do service stations insist on installing the newest and best tires on the front of the car? In my opinion, they belong on the rear. Am I right?—Noel Martin, Cynthia, Ky.*

A. I'd say you should have good ones on all four corners, because it is just about impossible to say which end is most important.

Q. *What are the advantages of the V12 engine used in your Eagles over other Grand Prix cars with a V8?—Chris Kennedy, Kensington, Md.*

A. In theory it can produce more power. However, in practice we have not achieved this in the form of usable racing power. Our engine also seems to require more oil and water cooling, and maintenance is more difficult. At the moment, the V8 seems to be the best compromise all around.

Q. *I've heard a lot about Hemis. What is the difference between a Hemi and a regular engine?—Dex Simanton, Auburn, Ind.*

A. The word "hemi" refers to the hemispherical shape of the combustion chamber in the cylinder head. It is an old standby in racing-engine design. Other head shapes are "wedge," "pent roof" and "Semi-Hemi." The difference is in the shape, location and number of the valves. The "pent roof" four-valve seems best for power.

Q. *What's going to be the next type of engine at Indy?—Phil Nash, Summitville, Ind.*

A. Turbocharged engines look good. So do standard-block, pushrod-operated valve engines. Pure turbines may still have a chance. There are rumors of steam engines. I think the conventional engine will remain competitive for another decade. Do you know anything about atoms?

If you have questions on racing, high-performance and everyday driving techniques, send them to "Drivin' with Dan," c/o Popular Mechanics, 575 Lexington Ave., New York, N.Y. 10022. Questions cannot be answered by individual letters. Questions on maintenance and repair should be addressed to the Auto Clinic (see page 72).

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STEP 3. Shape until dowel and pin fit into rod ferrule



STEP 4. Reeve line through safety-pin eye. Catch fish

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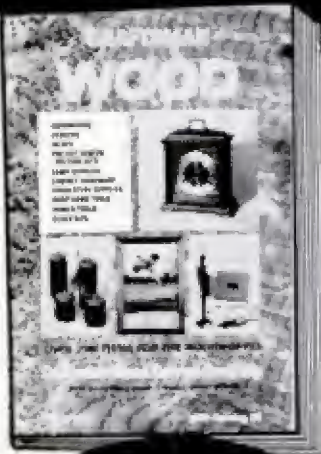
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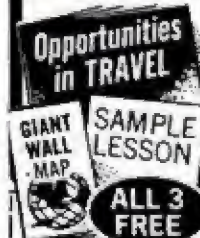
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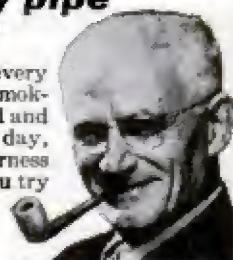
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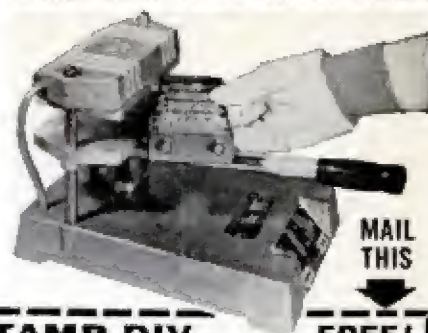
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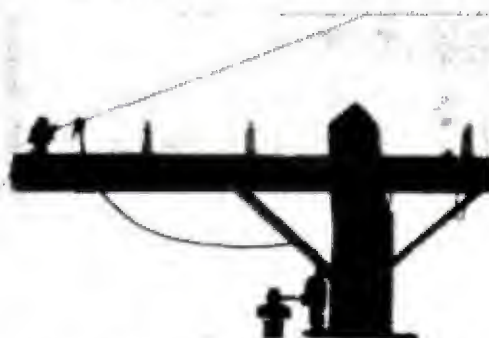
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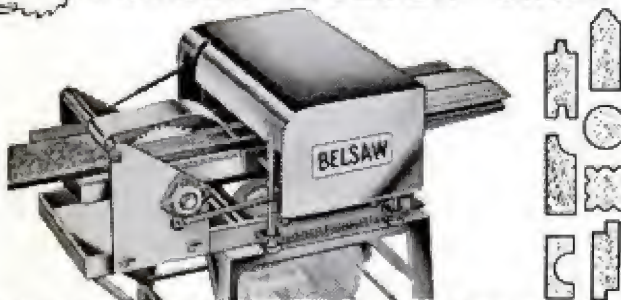
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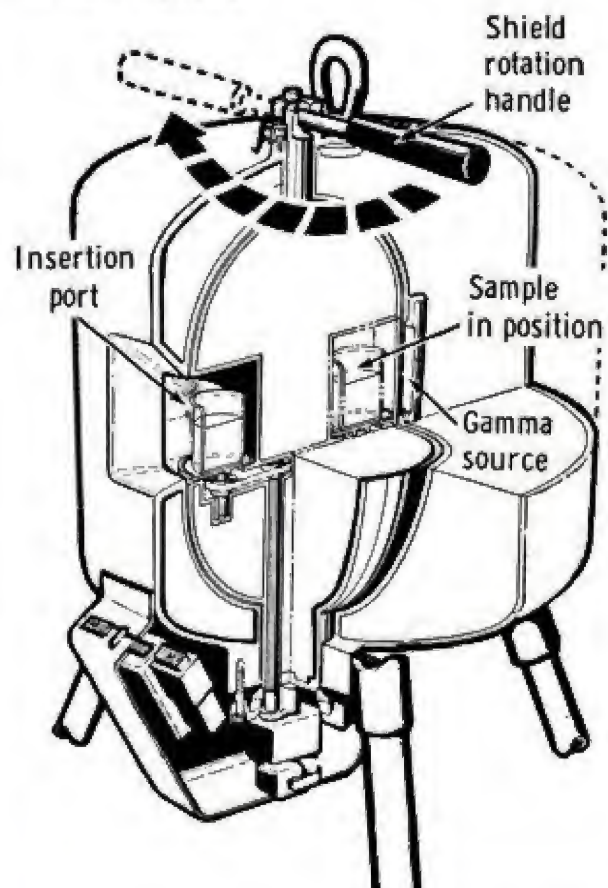
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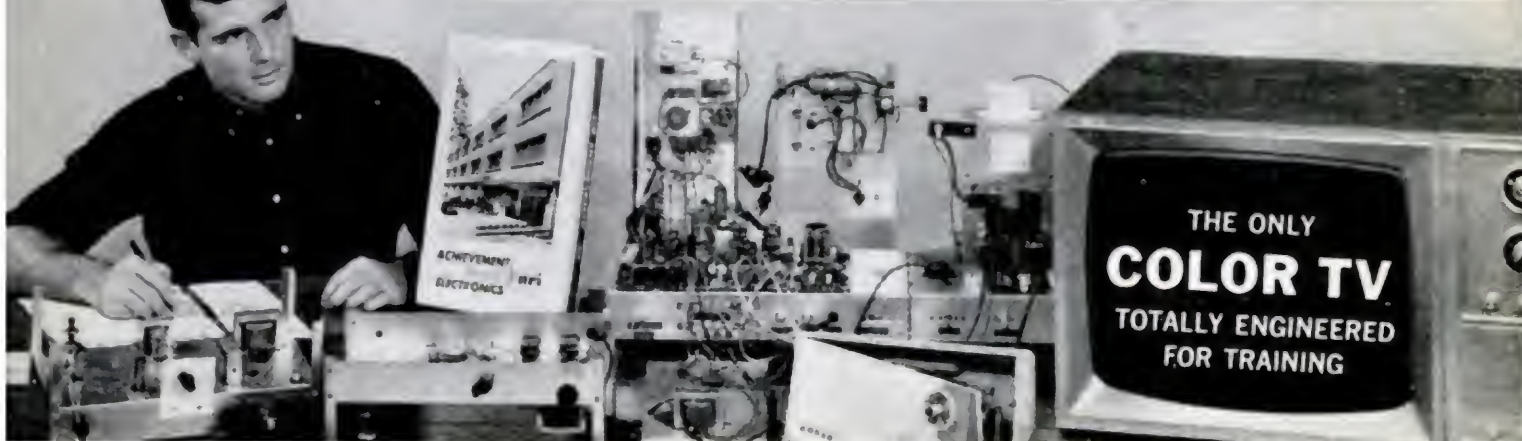
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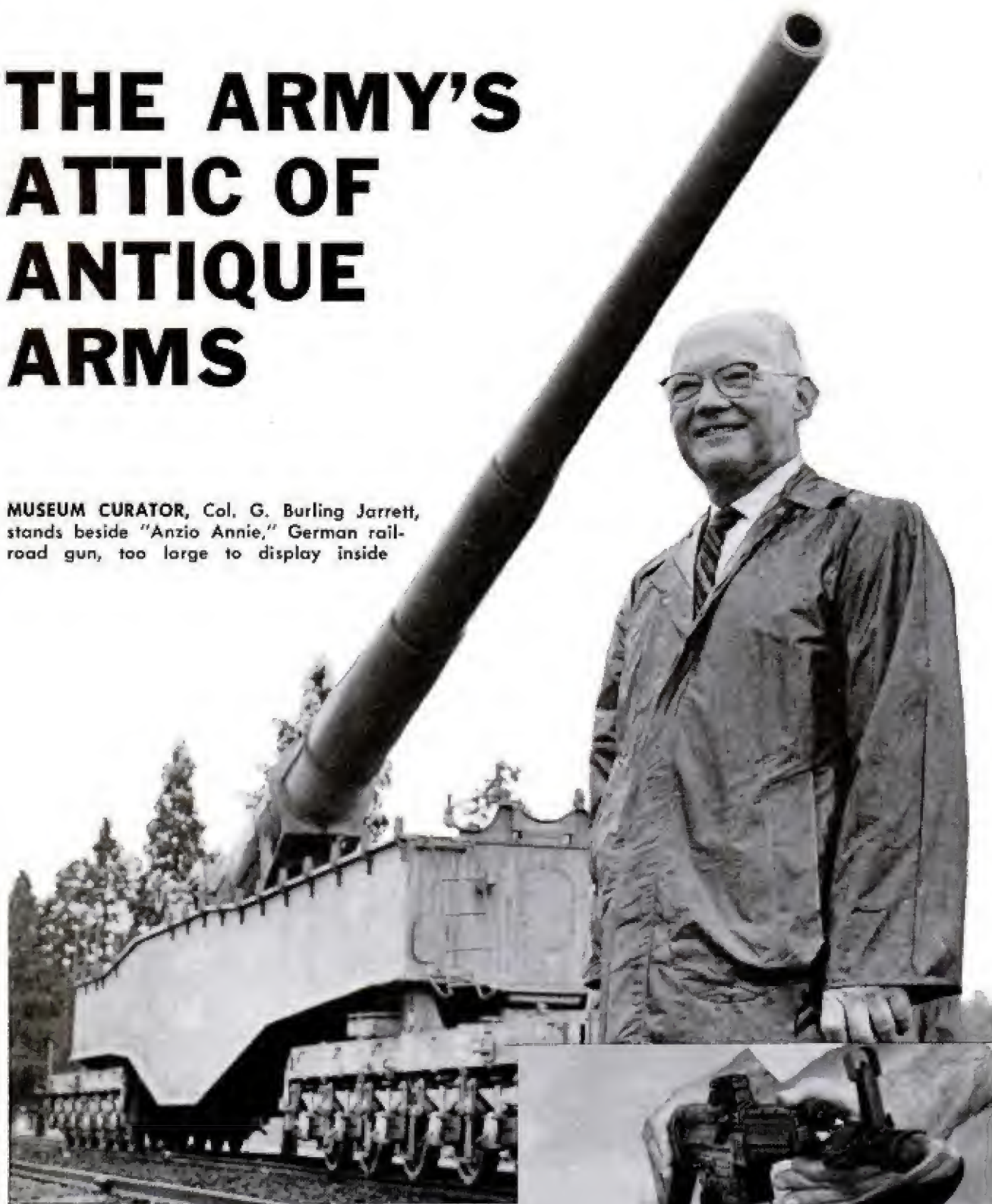
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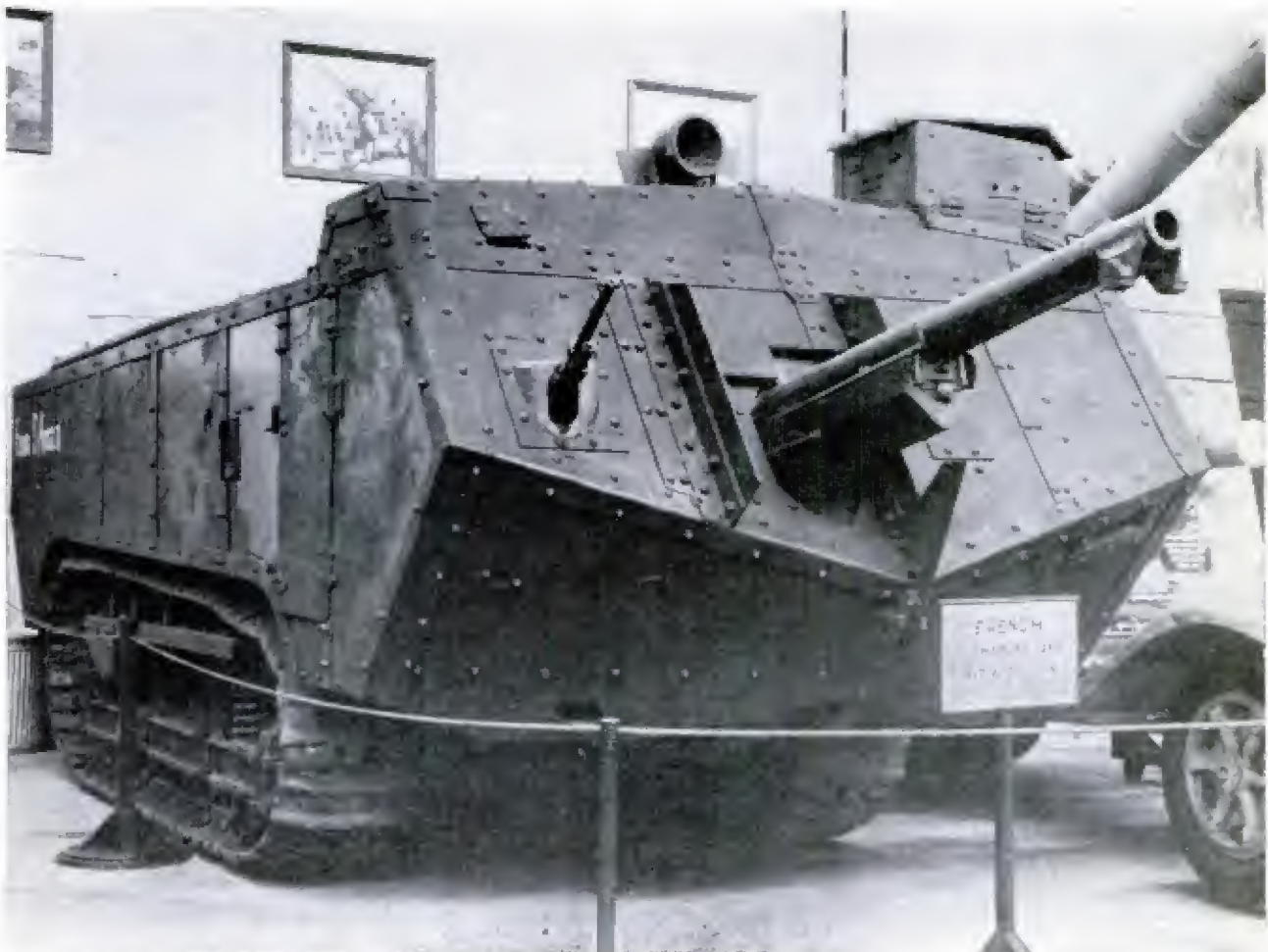
CURVED BARREL of German machine gun was designed to shoot around corners during World War II, but there is no record of whether it was actually used



MOST EXOTIC weapon in museum is this World War II Japanese combination: a sword that uses automatic pistol as handle



CHINESE PISTOL (right, top) is copy of famous German Mauser automatic. Chinese gun, however, fires only single shots



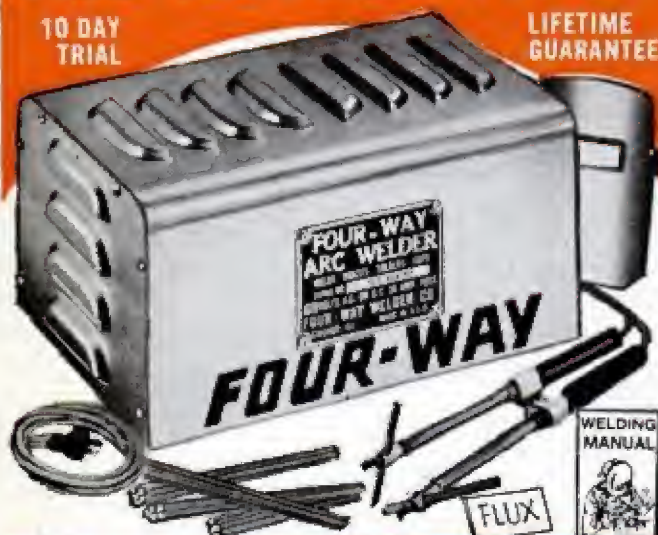
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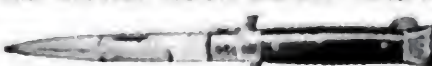
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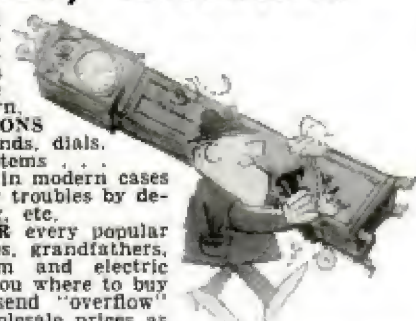
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NEWS BRIEFS



Deep-sea demitasse

These Styrofoam cups were once the same size. The one at left, though, was taken 8310 feet underwater in the Lockheed Deep Quest's free-flooding outer hull, where pressure is 3700 pounds per square inch.



Tethered Hummingbird

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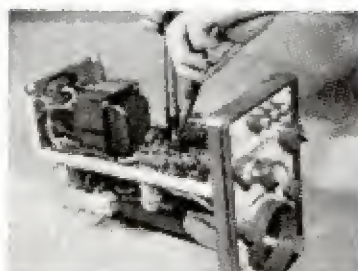
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SOLUTIONS FOR MECHANICAL HEADACHES

AUTOMOBILE CLINIC

BY MORT SCHULTZ

Foul play

Even after tune-ups, my six-cylinder 1966 Mustang quickly fouls sparkplugs. Other Mustang owners I've spoken to seem to be having the same trouble. Have you heard about this?—Dennis Hunt, Warren, Ohio.

Yes, and there seem to be two primary reasons behind it. The trouble could be faulty valve-guide seals or it could be with valves that flap around inside the valve guides. In the first case, a set of new valve-guide seals will solve the problem. But in the second situation, the cylinder head will have to come off and the valve guides trued up. In that case, I would switch to a valve that is no more than .003 in. oversize in order to firm things up.

Small torque

A few weeks after having motor work done on my 1966 (Canadian) Studebaker, I noticed that my engine was covered with oil. Though I cleaned it off, it reappeared after several more miles of driving. What has the mechanic done wrong?—Edward Lee, Lexington, Ky.

I can take a guess. This car takes a neoprene-covered cork gasket for the rocker arm, and this gasket takes less torquing than plain cork gaskets. It is likely that the mechanic simply over-torqued the rocker-arm screws, which resulted in distortion of the gasket. I'd have a new gasket installed and, if it happens to be neoprene, remind the mechanic that the correct torque is 40 to 55 in./lbs.

Getting the rap

Despite new hydraulic valve lifters, a reground crankshaft, and new main and rod bearings, I still get a loud rap for three to four seconds when starting my 1963 Chevy. There seems to be an oil-pressure delay. Could it be due to the oil filter filling with oil and is this something to worry about?—Norman G. Ziesse, Pittsburgh.

No, the oil filter has nothing to do with it. Yes, it's something to worry about. That rapping you hear indicates that your

bearings are operating without oil. If they continue to do so, they'll soon be ruined. Apparently you have an oil leakdown problem. More than likely, you'll find that the trouble's in the oil pump, which could have a bad check valve that isn't holding properly and is allowing oil to drain out of the lines. As an alternate possibility, there could be an internal leak.

Speedometer seminar

Auto Clinic has been receiving an increasing number of letters that describe speedometer troubles. To try to answer all in one clip, here's a diagnosis chart. As you road-test your car, watch and listen for the following defects, then tackle the probable causes, taking the easiest one first. For example, tighten a cable nut to see if that helps before replacing a cable.

Defect	Probable Cause
Slight needle flutter (no noise)	<ul style="list-style-type: none"> • Loose cable nut • Defective drive and driven gear
Severe needle flutter (no noise)	<ul style="list-style-type: none"> • Loose cable nut • Bent cable core • Kinked or pinched cable housing • Excessive grease in the speedometer head
Speedometer not working	<ul style="list-style-type: none"> • Broken cable core • Defective drive and driven gear • Defective speedometer head
Clicking or ticking noise	<ul style="list-style-type: none"> • Loose cable nut • Defective drive and driven gear
Grinding noise	<ul style="list-style-type: none"> • No lube on cable core • Defective drive and driven gear
Ringing noise	<ul style="list-style-type: none"> • Defective speedometer head

Two-timer

I have a 1968 Ford with 302 V8 engine. In only 6000 miles I've had to have the ignition timing set three different times. On each occasion, the mechanic said it was way off and he didn't know why. What's wrong? Why doesn't the timing

(Please turn to page 74)

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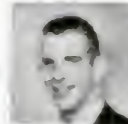
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AUTOMOBILE CLINIC

(Continued from page 72)

stay put?—Glen E. Wright, Broken Bow, Neb.

It's possible that the distributor isn't being locked up tight, but I doubt it. The distributor in this car and in many other 1968 Ford models is of the dual-diaphragm type. This setup is supposed to allow for surer and better spark advance. Anyway, there's a knack to timing a car with this kind of distributor. It's a lengthy procedure, so tell your mechanic, tactfully, to consult the service manual and make sure the ignition is timed twice—once when the engine's cold and again when it's warmed up. A conventional timing procedure just won't work.

Wind song

Maybe you can tell what's causing a noise in my 1965 Pontiac. This low-pitched whistle occurs only when the windshield wipers are operating, and then only when the wipers are in an up position. Any ideas?—Jack Gibson, Kansas City, Mo.

It's a long shot, but maybe air is being swept by those windshield-wiper arms into an opening in the upper windshield reveal molding. If I'm right, you can get rid of the noise by getting some nonhardening windshield sealing caulk from an auto supply store and spreading it beneath the molding to close up any opening.

Voices of experience

Three readers writing about items previously covered in *Auto Clinic* offer these tips from their own experiences:

Spec. 5 Jim Garthwaite writes from Vietnam that the VW 1300 choke problem noted in the April '68 column "can be caused by the carburetor throat being squeezed just enough by tightening the air filter too much. This binds up the butterfly valve on the choke." Thanks, Jim.

Larry Zink of Morgantown, Ind., comments on the banging noise Fred Wolff of Paterson, N.J., wrote about (July '68). "I had the same noise with my Ford," Larry says. "I thought it was the exhaust system until I raised the car up and down and took hold of the rear shock absorbers. I could actually feel the noise right in

the shocks. I replaced the shocks and the noise went with them."

Dick Willman of Philadelphia discusses "A Matter of Lubrication" (July '68), which covered the groans and vibration noise from a '64 Chevy. He says: "Differential companion spline noise often sounds like a U-joint clank. Since the driveshaft is torqued in forward motion (clockwise) most of the time, the companion flange will change direction when the car's put into reverse and accelerated slowly. Twist on the pinion shaft sometimes gives noise similar to a bad U-joint. This can be corrected by removing the companion flange and lining the splines with white lead."

Service Tips

● **1968 Toronado** headlight grilles may be heard popping open while you're driving down the highway in broad daylight with your lights off. It's normal. This system is designed to provide an extra air flow through the radiator when coolant temperature exceeds 220° F. To get that added air flow, a remote control valve is put into the system to open the hide-away headlight doors.

● **Chrysler Corp.** reminds owners of its cars that premature rear-brake lining failure can result if the parking brake cable isn't properly adjusted.

● **1968 Ford and Mercury** owners would do well to double check the routing of power-steering hoses following the servicing of their cars. Sometimes these hoses are moved from their original position by a serviceman who is trying to get more room in which to work. If the hoses are accidentally left in contact with the exhaust manifold, they can start to burn through. A glance will tell you if a hose is touching the manifold.

● **1968 Chevys with V8 engines** should have their oil filters more than hand tight. Unless they are torqued to 25 ft./lbs., leaks can result. You can approximate the proper torque by bringing the filter up snug to the base, then giving it one to one and a third additional turns.

● **1968 Ford Fairlane** owners may have a problem with a front fender contacting or being "grounded" to the bumper. The trouble is loose front-fender brace attachments. Your dealer is authorized to correct it by item 1300, service bulletin 86. ★ ★ ★

GOT A PROBLEM WITH YOUR CAR? Ask Mort about it. Send your question to Auto Clinic, Popular Mechanics, 575 Lexington Ave., New York, N.Y. 10022. Letters cannot be answered individually, but problems of general interest will be published in the column.



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HOMEOWNERS' CLINIC

BY W. CLYDE LAMMEY

Painting brick house

I have an old two-story home with boxed cornices, dentil molding—all the trimmings of years gone by. But the walls are brick and I don't like their pale, reddish color. I'd like to paint the walls this summer but can't decide on the color. The trim will be white or, perhaps, off-white. Any suggestions?—J.R., Tenn.

I hesitate to agree with the painting of brick walls of homes—brickwork just doesn't look like brickwork once it's painted. Also, if you change the color of the bricks and cover the mortar joints you may change the appearance of the house—making it look larger or smaller. Moreover, you add the periodic maintenance chore of repainting the entire structure instead of just the trim, a cost factor that should be considered. If the brickwork is still in good condition I'd strongly recommend that you let well enough alone, especially if your home blends well with its surroundings. If you must paint, a light gray often goes well with white trim—however, the selection often depends much on the architecture of the structure. White also seems acceptable to some owners of brick houses. Sometimes a tile red is used.

Renewing gilt

I have an old rectangular picture frame with a liner which I'm sure is gold leaf. The liner is shaped with two beads and a flat portion. On the latter the gold leaf has become dull and pitted, but the beads are still bright and smooth. Is there some way to renew these surfaces without applying gold paint which eventually will tarnish?—T.D., Mo.

As a rule, liners are softwoods. Thus, it could be that the leaf has been cracked or broken by shrinkage and expansion of the wood through the years. This and an accumulation of dust could give the dull appearance. I would try a very mild, but soapy, wash, taking care not to wet the surface excessively. Apply the mild solution with a dampened ball of cotton and rub very lightly. This should remove the accumulated dirt and quite possibly will brighten the gilding appreciably, but it is

not likely to hide the pits. Dry burnishing with a ball of clean cotton may also help to bring up the glow of the gilding. But, judging from your description, you'll either have to live with the pits, have a new liner fitted and gilded, or resort to a gold wax on the affected flat portions. The gold wax, or "wax gilt" as it is sometimes called, is quite effective for restoration projects. It's applied with a fingertip and then burnished, but doesn't tarnish as do most gold paints. (See *Antique Gilt Goes on Like Wax*, page 128, Aug. '68 PM.)

Squeak hunt

An annoying squeak has developed in my forced-air furnace. I've tried every way I can think of to locate it but I still have the squeak. The noise can be heard upstairs when the blower is operating. It sounds like a metal-to-metal squeak, but where?—D.P., Mich.

If you're sure it isn't the V-belt (assuming you have a belt-driven blower), the search should center first, on sheet-metal screws which may have loosened and, second, on parts of the fan and motor mounting. Turn the thermostat up until the furnace starts cycling. Then begin the hunt by pressing with a finger at various points over the outside of the sheet-metal jacket. If this doesn't pinpoint the squeak, open the blower compartment and repeat the procedure. Touch all the sheet metal, especially the wall between the blower and exchanger compartments and also the motor mount. Be extremely careful when pressing on parts of the mounting when the unit is running; don't get a shirt sleeve or finger caught in the machinery.

This procedure may take some time, but if you persist, sooner or later you are almost certain to touch the part causing the squeak. The rest is easy; tightening a screw or spraying the troublesome sheet-metal joint lightly with a nonflammable silicone compound usually stops the noise.

Patio chair stains

I have an aluminum patio chair that leaves a black stain on clothing. A grayish coating covers the metal. What is this, and how can I prevent it?—W.W., Tex.

An oxide coating forms on many metals exposed to the air, especially aluminum. The only thing you can do about it—and it's only a stopgap cure—is clean the metal and coat the "wear" surfaces with a metal lacquer. Any clear finishing material will do, but genuine metal lacquer will do the best possible job. ★★★

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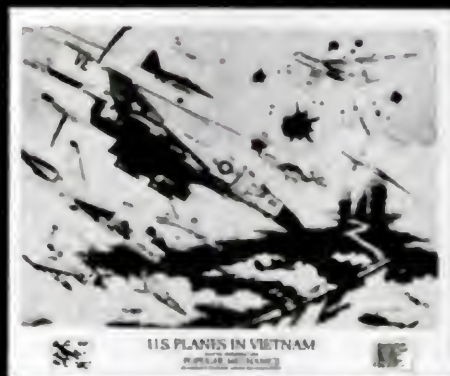
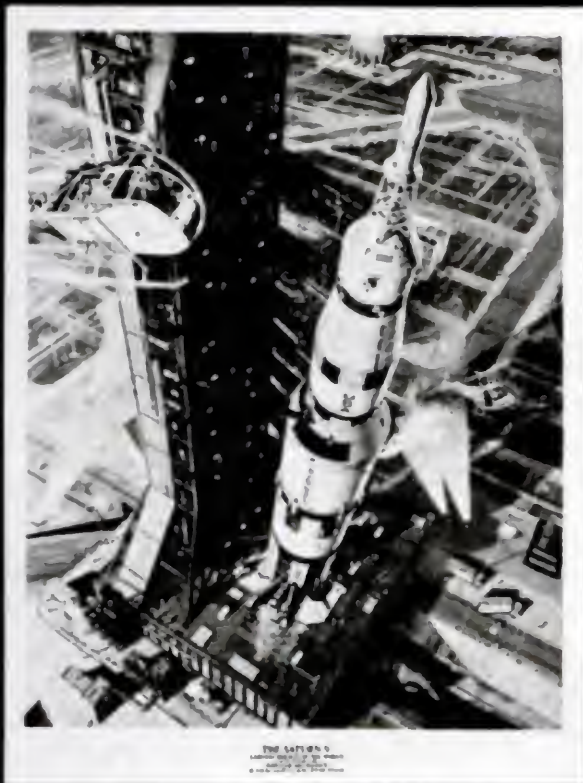
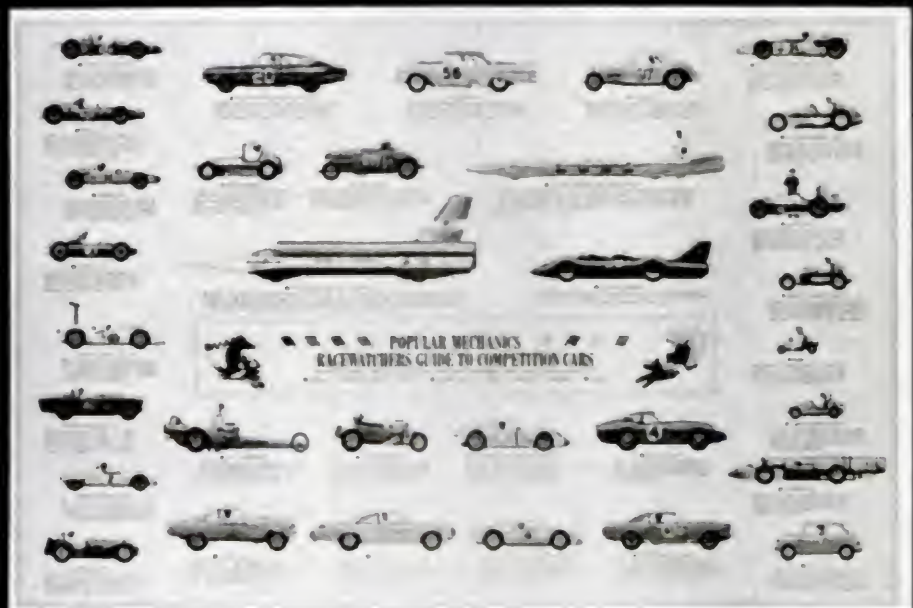
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How the Army Learned to See In the Dark

Here's the inside story of the Army's supersecret gun scope that intensifies images up to 50,000 times and gives gunners daylight vision in pitch-black darkness.

By MORT SCHULTZ

PICTURES of Russian tanks squashing the Hungarian revolution in 1956 revealed that the giant turret-mounted searchlights those tanks had been carrying were missing. How were the tankers able to see at night?

Maybe the Soviets didn't need lights for this operation and had removed them. But was it possible they had developed a system, now mounted inside the tanks, which would let



WITHOUT SCOPE
Gis can see only a few feet

WITH SCOPE
Scene is 50,000 times brighter

STARLIGHT SCOPE intensifies dimmest light, even fluorescence of rotting vegetation in Vietnam, up to 50,000

them see in the dark with the nighttime sky as their only light source? This could be disastrous for U.S. troops if war ever came.

At the time, our most effective night surveillance equipment was the famous, but obsolete, infrared Sniperscope of World War II. Infrared can't be seen by the naked eye, but viewing devices can convert this invisible beam to visible light. A soldier using one of these detection devices can see the infrared beam as if it were a searchlight and can trace it back to its source.

THREE VERSIONS of Starlight Scope include small scope mounted on infantryman's rifle, large tripod-mounted scope and medium-sized scope (shown below) mounted on machine guns or recoilless rifles

Supporting the possibility of a Soviet breakthrough in the critical night-vision field was the fact that Germany had been on the verge of developing such a system, called passive image intensification, when World War II ended. Several of Hitler's key optical scientists who had worked on the program were in Russia.

According to some nonofficial sources, the U. S. Army couldn't take any chances and assume that the absence of searchlights was of minor importance. Immediately, they contend, our own basic research in the field, which had started in 1952, increased.

This work was given a meteoric boost in 1961 when Dr. Louis Alvarez told President Kennedy that our Army was unprepared to fight at night. Alvarez was head of a committee investigating the ability of U. S. forces to engage in limited war.

Suddenly, the 30 scientists of the Night Vision Laboratory at Fort Belvoir, Va., found themselves with millions of dollars and an order: Use your research to develop a



times. It robs enemy like Vietcong of one of their favorite weapons—sneak attacks in pitch-black darkness

piece of hardware that would take the blindfold off our troops as soon as possible. The laboratory, whose ranks swelled (there are now 300 assigned to the group), had that equipment, called Starlight Scope, ready for use in 1965.

Naturally, as the first scopes were sent to Vietnam, the development remained a secret to keep the Vietcong from knowing that we had something that would let our troops operate as efficiently in the dark as in daytime. However, several scopes have been captured; security is no longer necessary.

What makes this device work? That's what I wanted to know about this most fascinating piece of military equipment I have ever used.

According to Dr. Martin Rome, the scope consists of three main components: an intensifier tube, an optical system and a power supply. Rome did initial development work on image intensifier tubes as a member of Machlett Laboratories in Stamford, Conn. He is now a vice-president of Electro-Mechanical Research, Inc., Princeton, N. J.

The three components literally absorb the dimmest nighttime illumination (starlight, the moon shining through the clouds or, as in the jungles of Vietnam, the fluorescence of rotting vegetation) and amplify it into bright light, allowing you to see everything

around you. Hard to believe? Let me describe my experience in a cornfield at 10 o'clock on a cloudy night.

What had been utter blackness—I couldn't see my hand smack to my face—transformed to a scene of razor-sharp clearness when I held Starlight Scope to my eye. It was as if a hundred spotlights had suddenly been switched on. The only difference between the light I was seeing by and daylight was an eerie pale-green aura emitted by phosphor in the tube. It bathed the scene. Charles D. Jackson of the Machlett

NIGHT-OBSERVATION DEVICE is largest of scopes, weighing 38 pounds. It has range of 1300 yards and is generally used by night observation teams



Laboratories described what my Starlight Scope had done this way: "About 50,000 times more light came out the back end of that scope and into your eye than went in the front."

The key to this tremendous amount of intensification is the intensifier tube. Each end of the tube contains a fiber-optic lens, which traps light. The lens in the front is coated with a photo-emissive substance. This photo-cathode coating, like that of a TV camera tube, gives off electrons when struck by light.

Photo cathodes used in commercial television couldn't be used for Starlight Scope. They aren't sensitive enough to excite electrons under low-level illumination. In 1955, though, Dr. Al Sommer of RCA found a photo cathode which far surpassed in sensitivity those used for TV. This coating, consisting of cesium, antimony, sodium and potassium, was adopted for Starlight Scope.

Once the photo cathode begins emitting electrons, the intensifier tube steps up their speed and controls their direction. Amplification is accomplished by 15,000 volts of direct current. Control is the job of a concentric electron optical system which, like a camera lens, directs the image to a piece of "film." In Starlight Scope, the "film" is a phosphor coating on the rear fiber-optic lens.

According to Mike Klein, associate director of the Night Vision Lab, "the concentric optical system is a lens for electrons that's made from the metal,

kovar. Part of the configuration is shaped into an anode cone. Voltage applied across the metal pushes electrons through the small aperture of the cone. It's the job of the metal electron lens to shape and focus the electron image."

Kovar, an alloy of nickel, cobalt, iron and manganese, is highly conductive and is the one metal which fuses best to the glass of the intensifier tube. The metal is also nonmagnetic and highly resistant to weathering and corrosion.

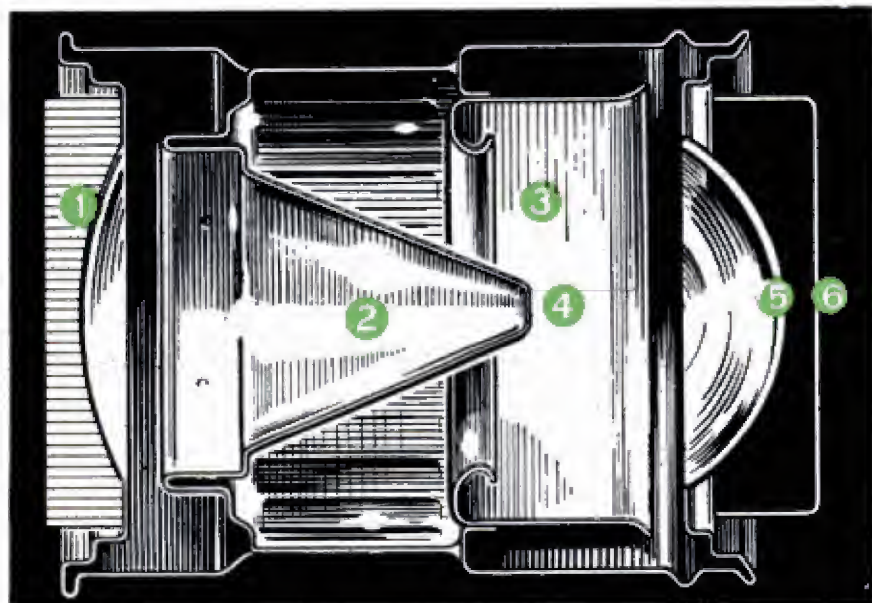
The electron lens was developed by Peter Schagen in the late 1940s when he was a member of Philips Laboratory in Eindhoven, Netherlands. It's accepted worldwide as the electron optical system for tubes.

When the electrons are given the voltage jolt and push through the small aperture of the anode cone, they slam into the thin phosphor coating of the rear fiber-optic lens. A phosphor emits light when excited by electrons. Thus, the impact of the electrons on the phosphor produces an image that's 30 to 50 times brighter than what comes into the front of the tube.

But one little intensifier tube will not produce a bright enough image for field troops. Nor two tubes. But three will. So, for maximum amplification, three tubes are butted together, the rear fiber-optic lens of one in contact with the front lens of the other.

Each tube amplifies brightness 30 to

(Please turn to page 224)



HERE'S HOW scope works. Light hits fiber optic lens (1). It is coated with photo emissive substance which gives off electrons when struck by light. 15,000 volts are applied, forcing electrons through anode cone (2). Cone and adjacent configuration (3), made of special metal comprise optical system, shaping image as electrons speed through cone's aperture (4) and slam into phosphor coating (5) of fiber optic lens (6). Coating is like film in camera, receiving the image for viewing



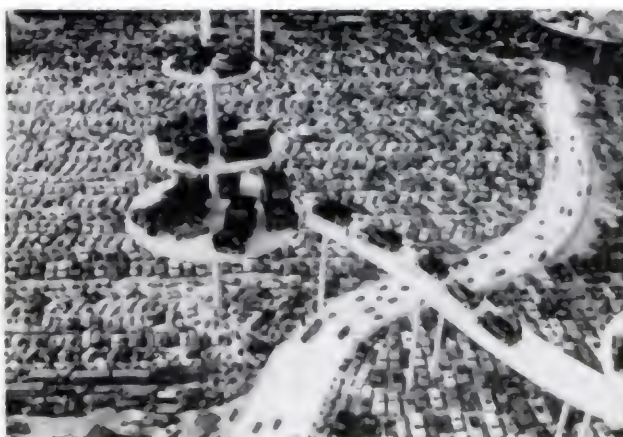
Just listening—they say

When Munich policemen hear an unusually loud motorcycle, they take it to their "listening station" and actually measure its decibel output. Too much noise means a ticket—even for a pretty girl in a miniskirt.



Fizzy well

Max Blekeman, an Australian farmer, has tapped an underground supply of water that's charged with pure carbon dioxide. It's even shipped 250 miles to Sydney for bottling.



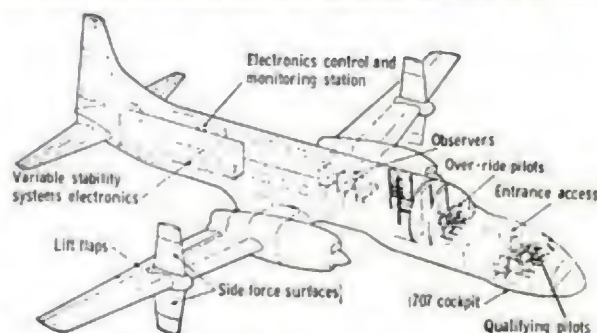
Super traffic jam

Though it looks like Times Square at 5:00 p.m., it's a display of 10,000 miniature cars by a model-car club in Tokyo.



Out for a spin

Alan Howitt of England borrowed an idea from the railroads in order to make his way safely onto a busy street in front of his home. He built a turntable in his driveway so he never has to back out into the road.



Pinocchio plane for training

Air Force and airlines pilots will begin training this year in a Convair 580 that has an extended nose containing a second cockpit that simulates anything from a commercial jet to a supersonic transport. The plane, called a Total In-Flight Simulator (TIFS), has a computer aboard that creates the flight characteristics of the plane that the trainees will later fly. Tex Johnston, Inc., makes the TIFS.

Your Second Car May Be

The classic half-tonner, once the workhorse of rural America, is pushing to be suburbia's all-purpose fun car, and the '69 pickups are here in red, white and blue to prove it.

Photos by Jeannie Weaver



By **BILL HARTFORD**
Associate Auto Editor

CAN A 100-POUND WISP of a woman jockey around a "half-ton" truck and still preserve her femininity? In a new 1969 pink pickup she can—and you can bet your eight-foot cargo box on that.

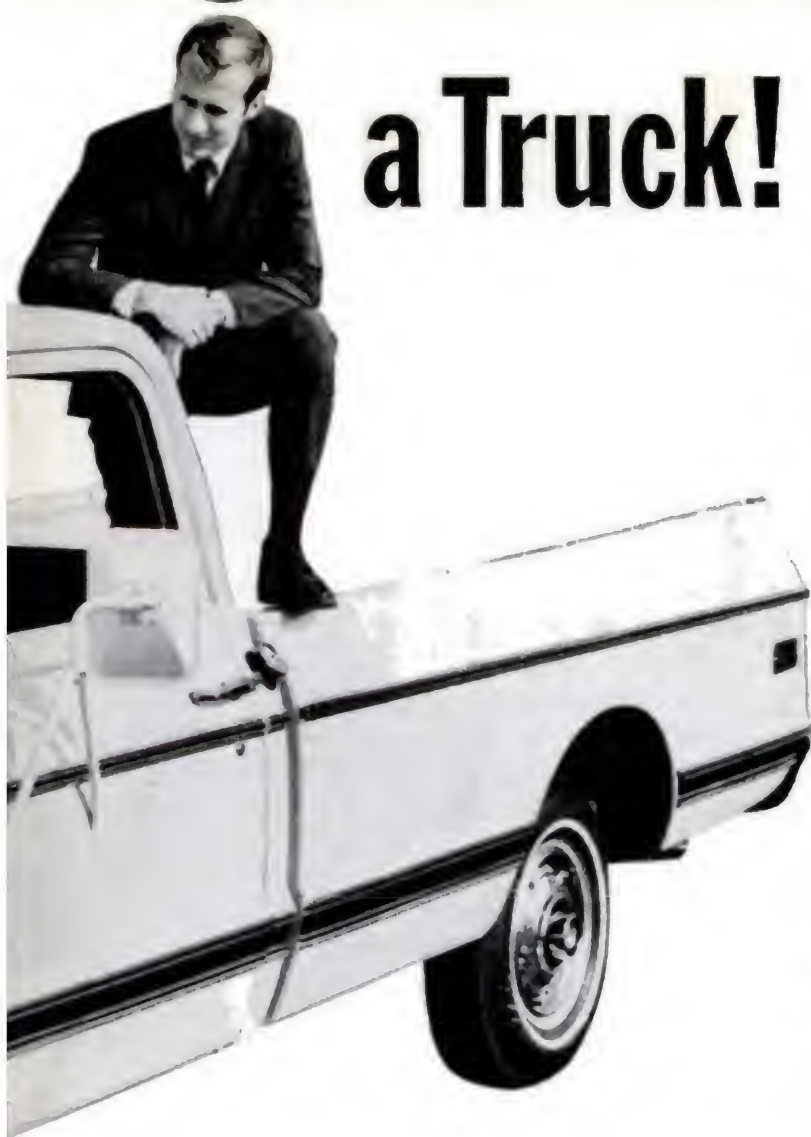
Don't think that the new pickups have been emasculated just because they've gone soft on that old, hard ride and are sporting woman-pleasing, deep-pile, color-keyed and coordinated carpeting. Of course, *you* don't need airconditioning, power steering and brakes, two-tone paint with wood-grain trim, vinyl roof and stereo tape—not for loading hay you don't. But the pickup is becoming almost—but not quite—too uppety to work. As its sales

soar for use as a recreational vehicle, the compliant pickup is being engineered, fashioned and outfitted to be comfortable and stylish to all the members of the second sex sliding behind the wheel.

"Built to be womanhandled," advertises one manufacturer; "his and her transmission," brag a couple of others who have a manual/automatic transmission; and even Auntie Martha is out loading up antiques as another advertisement pictures the typical "work" situation.

So be forewarned, men, while you're mentally juggling average job loads and sizes and deciding on the best suspension, wheelbase, transmission and engines for

a Truck!



THE BIG SIX of light trucking are out in force for 1969. Chevy's CST/10 (above) has new front-end styling, 350-cu.-in. V8. Ford's F-100 with 131-in. wheelbase offers Contractor and Farm & Ranch work packages. International 1000D is the basic pickup in company's all-new lineup of vehicles for '69. Four-wheel-drive Jeep J-3000 Gladiator is both rugged and streamlined. Dodge Adventurer's vinyl roof typifies "sports truck" trend. GMC Sierra Grande model comes loaded with luxury

your pickup, or rather, the family's second car, the woman in the family will already have decided that she'd look chic in a pickup painted 1969's sweet new hue: prairie gold. Or should it be lime? Plum? Spruce tip? Maybe Bahama blue metallic?

Well, at least the Mack truck bulldog is still head-high on the hoods of the big rigs. Square-jawed and steadfast, he hasn't been replaced by a fluffed and ribboned poodle. *Big business is all business.*

But any lightweight that tips the scales around 5000 pounds up to 10,000 pounds GVW (gross vehicle weight) is registered, at least in part, for f-u-n! According to an executive of one of light trucking's



FORD



INTERNATIONAL



JEEP



DODGE



GMC



PICKUP INTERIORS must be seen to be believed. Standard and optional equipment and appointments like courtesy lights, carpeting, embossed bucket seats, airconditioning and stereo can make a very cozy cab



CONVENTIONAL WISHBONES and coil springs are used by GMC and Chevy in their front suspension design. On half-ton, springs are 1250-lb., 1350 optional

FOUR-WHEEL DRIVE, standard on Jeep, optional on other pickups, is a must for off-the-road operation. Semi-elliptical leaves and shocks suspend front axle

Big Six, the percentage of light trucks used strictly for business is down to 20! Of course, a good number of the pleasure-bent other 80 percent double up for both work and play.

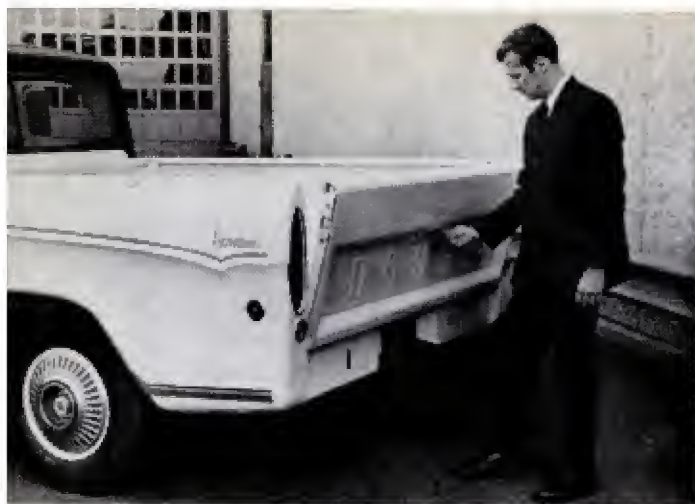
It's this versatility that's really putting record numbers of pickups on the pike: Just remove the workday contractor box and slide on the camper unit. Beautiful! Leave the landscaping business in the garage and tow the boat to the lake for spring launching. Simple! Clean up the snow in the neighborhood and then unbolt the plow and go hunting. A snap! Leave the aluminum siding at the warehouse and load the lumber for the upstate cabin. Payload to payload versatility. Terrific!

Utility and good looks are what meets the eye with all the '69s, but if you're serious about pickin' a pickup from among the hundreds of models and variations, you've got to take a long, hard look. Before you get too far, you'll sort out



COMPENSATING SHACKLE of Ford's Flex-O-Matic rear suspension pivots to adjust leaf spring stiffness





CONVENIENCE AND SAFETY FEATURES on current crop of pickups include easy one-hand tailgate operation with hinged tailgate support straps on full-width cargo boxes, and from Chevy, new Below-Eye-Line mirror

the fancy terms, all of which refer to the same thing—like Flareside, Stepside, Uti-line, Thriftside and Fenderside. The last of the designations is the most descriptive; it refers to those pickups with the cargo box running between the inside of the two rear fenders; the fenders are outside the box. The Styleside, Fleetside, Sweptline, Townside and Wide-side models have—you guessed it—a cargo box flush on the outside; the fenders are inside the box. Both types have the same dimensions between wheel wells—about 49 or 50 inches—but the latter models look slick, have wide tailgates and greater cargo capacity—and price tags.

Total payload, one of the most important considerations in selecting a pickup for your own particular requirements, cannot be inferred for a specific model by the almost obsolete references to "half-ton," "three-quarter ton," and "one-ton." So-called half-ton units, for example, vary

in payload, the maximum being well over three-quarters of a ton. Choice of short and long wheelbases does nothing to decrease your confusion quotient.

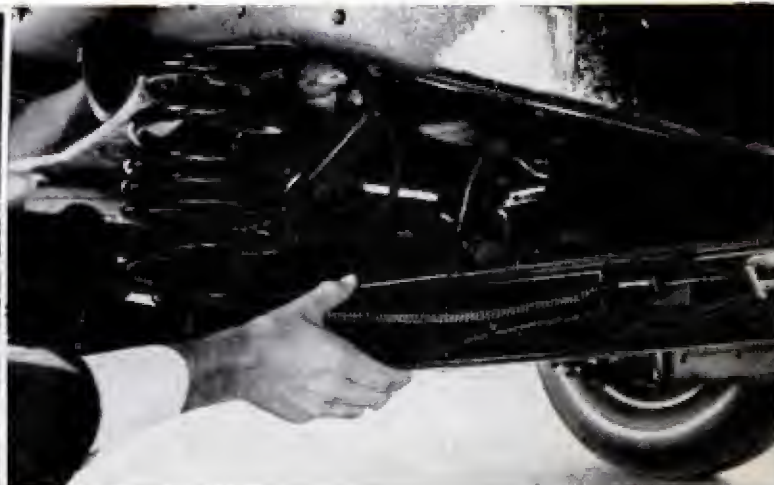
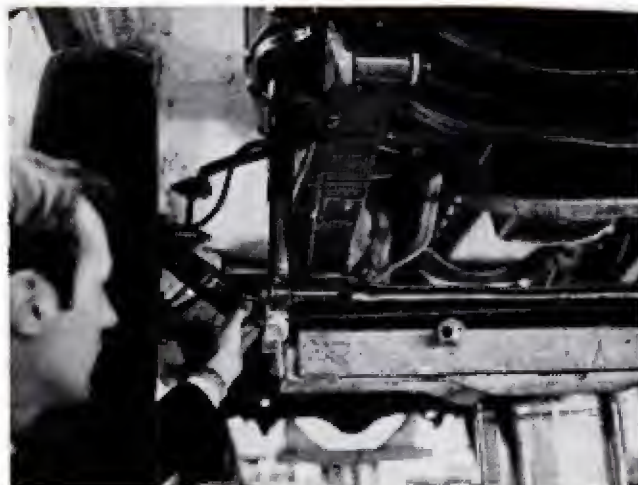
One manufacturer says, "We invite comparison," and the only thing to do is to take him up on that. Drive them all. And don't expect to find one that *really* rides like a marshmallow. You'll still know you're in a truck, but probably it will be the most comfortable, lowest, handsomest, most powerful pickup you've ever driven. Here are a few of the highlights of the '69 lines:

● **Chevrolet.** Automatic chokes are now standard on all engines, including the new 350-cu.-in. V8, successor to the 327. Two sixes, 250 and 292 cu. in., and 307 and 396-cu.-in. V8s complete the engine availability. Wheelbases are 115 and 127 in. in the CS/CE 10 (½-ton) series, 127 and 133 in. in the CS/CE 20 (¾-ton) series

(Please turn to page 194)

I-BEAM FRONT AXLE on Dodge trucks has been improved by addition of a sway bar for better control

TRAILING ARM/COIL SPRING, standard on some rears, needs auxiliary leaf option for a top payload





CAR STYLING is compromise between what looks well and what works, plus economics of what costs least

Why Your Car Looks The Way It Does

Those brand-new styling features may be as much as 10 years old. It can take that long to move a car from the drawing board to an assembly line

By **MICHAEL LAMM**

TODAY was three years ago and, with luck, tomorrow might come in 10 more. That's the way Detroit designers view their basic timetable.

Those sparkling 1969 models might look brand-new to you, but they're old hat in Detroit—two, maybe three years old. Advance stylists at General Motors, Ford, Chrysler and American Motors are doodling away at far-out drawings of cars that might be built sometime around 1978-80. In other studios, more down-to-earth designers are finishing renderings of the '72 models, and in still other locked rooms, design sculptors are putting final touches on full-sized clay models of '71 cars. The '70

models, of course, are pretty well set except for perhaps a wheel cover pattern or a few similar picky details.

All four Detroit automakers follow much the same routines and schedules in styling their cars. It's a complicated, painstaking business that involves lots of hands and brains plus plenty of compromise.

"Styling," says Dick Teague, design chief of American Motors, "may produce a car calling for an overall height



of 48 inches. Engineering may advise that the existing chassis will take a height more like 58 inches. What follows is an adjustment to a feasible design of, say, 54 inches."

Designers almost invariably try to utilize components already in production. This isn't only an economy of material but also of time, because it takes just as much manpower to design and tool for the unseen parts of a car as the exterior. If a company can keep from revising an existing model's underpinnings, it's a great saving.

For the year-after-year cars—the established industry nameplates like Chevy, Ford and Pontiac—facelifting

the next year's model might take as little as four or five months. A complete restyle, though, usually means about 36 months' hard work. And when it comes to putting a completely new car on the road (like a Toronado or a Mustang), preliminary research might stretch back 10 years or more.

With the Toronado for example, preliminary development and testing of front-drive assemblies plus body sub-frame design started as early as 1954, 12

model, let's take a look at the basic steps:

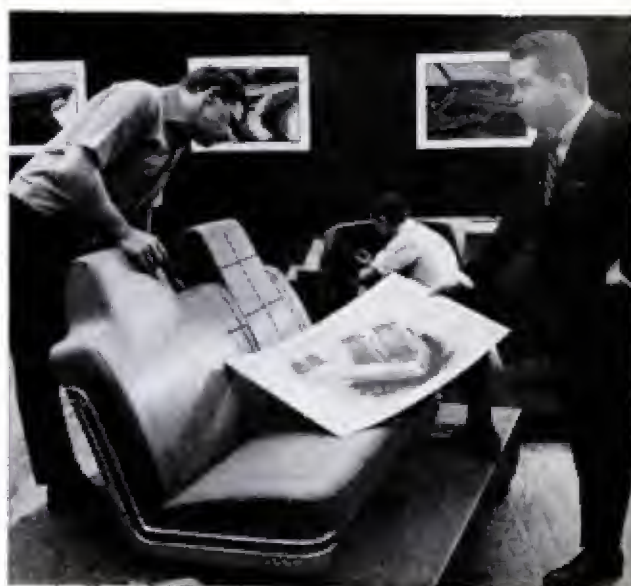
1. Management gets its collective head together to begin figuring out what sort of car will sell. What does a given market segment want three to five years hence? They work up a preliminary portfolio, then hand these basic requirements to Styling.

2. Styling takes this information (calling it a "paper car") about size, projected price, seating capacity, purpose,



years before the car saw the light of day. The LaSalle II show car unveiled at the 1965 GM Motorama was the Toronado's grandfather. Likewise, Ford started seriously chewing on the Mustang in late 1959, and in this instance it took FoMoCo only five years to give birth to a new model (April, 1964). But then the first Mustangs used a lot of Falcon components, and that made the production job easier.

The normal styling process can't be separated from pure research, market research, product planning, engineering, tooling, and several more big-biz pastimes. But to review the hypothetical, normal evolution of a changed



INTERIOR DESIGN is just as important as exterior. Seats must be comfortable, complement styling theme

... ideas and sketches that look good on paper might hit File 13 ...

and the sorts of people who will buy the vehicle, and they start drawing sketches. Styling might rough out hundreds, even thousands, of renderings within a few weeks. These quick sketches on translucent vellum consist only of basic lines, no details. The stylists keep eliminating and amalgamating designs until they boil the roughs down to a handful or two of likely candidates.

The more promising are made up as $\frac{3}{8}$ -scale clay models so they can be looked at in three dimensions. Sometimes the $\frac{3}{8}$ clays are modeled against a mirror so only one side needs to be sculpted, saving time. All the while, Management has been dropping in to the studios regularly, keeping tabs on progress and offering suggestions.

3. Interior designers, cloistered in separate but equal studios, go through the same pains as exterior stylists. At some point, when the various design processes reach a certain unspoken, but always recognized, stage, all the designers get together with Engineering and Management to begin ironing out details.

Engineering has actually been involved all along, but Styling takes the ball first, then theoretically it's up to Engineering to put running gear, seat-

ing, trunk space and so on into the package Styling presents. Here's where the business of compromise begins. Plenty of ideas and sketches that look good on paper might hit File 13 right away when Engineering starts making serious calculations.

4. A studio engineer or group of engineers begins to work out the details of making a chosen design practical—giving attention to hinge positions, making sure that optional equipment like airconditioning compressors will fit, deciding where to put mastic and sound-deadening materials, and so on.

5. Management now chooses several $\frac{3}{8}$ clay models for further development. Styling takes these and draws them up in side view, full size. These drawings are usually airbrush and watercolor on black paper.

6. At this point, too, both Interior and Exterior Styling get started on full-sized clay models. Skilled sculptors take full-sized drawings and the $\frac{3}{8}$ clays and begin work on the full clay over what's called an "armature." This armature is a wooden structure built to roll on regular car wheels. It's made of thin wood slats and sometimes Styrofoam for certain pieces, assembled in the rough shape of a car. Clay goes all over this armature. Contours and lines are smoothed to as near the final shape as possible.

It's the full-sized clays that Styling finally unveils to top Management for



CLAY MODELS are made when Styling and Engineering agree; then fiberglass molds are made from them



WOOD CHASSIS are built to hold full-size models for final changes in detail before making die molds

ultimate approval. Detail changes such as different taillights or a revised wrap to the bumpers are common at this point. But it's pretty late for major alterations in the basic body configuration.

These full-sized clays become the most crucial stage in the styling process, because it's here that most refinements are made. Sculptors work closely with stylists, Styling with Management, and small modifications are incorporated wherever necessary. The clay might be painted; windows are usually represented by black or plastic sheeting; metal foil gives the illusion



FINAL CLAY MODEL of AMC's Javelin is propped up for Management before car gets the final okay

of chrome on bumpers, door hardware, and so on.

7. Since full-sized clays aren't very stable—they're easily gouged and tend to crack after standing—the next step is to take fiberglass molds of them. This is done by first pouring a plaster fiber colloid over the clay, letting it harden, then lifting off the plaster cast with compressed air blown between the cast and the clay. The plaster then becomes the female mold for fiberglass layups. Basic clays can be changed for different body styles—wagons, convertibles, fast-backs.

The fiberglass may be cut so that doors and hoods open. Also, handmade dashboards, seats, door panels and so forth, worked up by Interior Styling, can be installed so the car becomes practically indistinguishable from a production automobile.

8. After fiberglass molds are pulled, body engineers go back to the clays for

precise measurements. The clays and styling drawings are translated into engineering drawings, very exact ones called "master drafts." These are scribed full size onto gridded aluminum plates with 12-carat gold styluses.

9. Now begins the *real* work of making the car practical. While the outer body sheet metal might have no more than 15 or 20 separate panels (doors, top, hood, trunk, rockers, fenders), the total body might incorporate as many as 4000 different pieces. It's up to the body engineers to figure out how to shape these unseen bits, how to make them go together in the most rigid, eco-



FINAL FIBERGLASS MODEL of Javelin is displayed, looking every bit as finished as production model

nomical and reliable fashion. It's just as tough to design the guts of a door or the cross section of a body side rail as the car's outer skin—tougher, usually. But it has to be done, and done precisely. Unseen supports, flanges, brackets, clips, hooks and the thousands of other details all have to be remembered and integrated into the final design.

10. The car has now gone far beyond Styling's hands. The logistics of actually building it go through another series of important steps, and these are worth reviewing quickly.

Pretest models, using newly designed underpinnings or whole chassis (if the car is entirely new), are mounted under current-year bodies to test for rigidity, possible pockets that might collect corrosives, and so forth. For the Toronado, for example, pretest cars consisted of 1963 Riviera bodies mounted on front-wheel-drive chassis. The Toronado's

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They're Putting the Old Birds

Once rusty and forgotten, some of World War II's most famous airplanes are taking off from the scrap heap to do jobs the jets can't handle

By **NORMAN SKLAREWITZ**

Photos by James Pickerell

IN A DESERTED CORNER of the Tucson (Ariz.) Municipal Airport stands a forlorn row of old World War II bombers that have had a reincarnation. No longer doomed to the scrap heap, they're being spruced up in combat colors for a war they were never built to fight.

Because of the spread of brush-fire warfare, once-obsolete warplanes are among the hottest items on military shopping lists. In many combat situations, a propeller-driven plane is more efficient than a much swifter jet.

It takes more than a new coat of paint to make these rusty old birds ready for action again, however, and several small aviation companies around

the country are giving the task almost custom-finishing attention.

In some cases the planes are being put back into better shape than they were originally. The A-26 is getting 2500-hp powerplants, replacing the original 2000-hp engines, plus larger rudders, tip tanks, antiskid brakes and reversible props. About 90 percent of the wings are new, too, permitting eight .50-cal. machine guns, and four pylons under each wing for an assortment of bomb loads.

The P-51, a great fighter in its day, may be even better today. It's a considerably more powerful aircraft than the one turned out over 25 years ago by North American. The new version



Back Into Battle

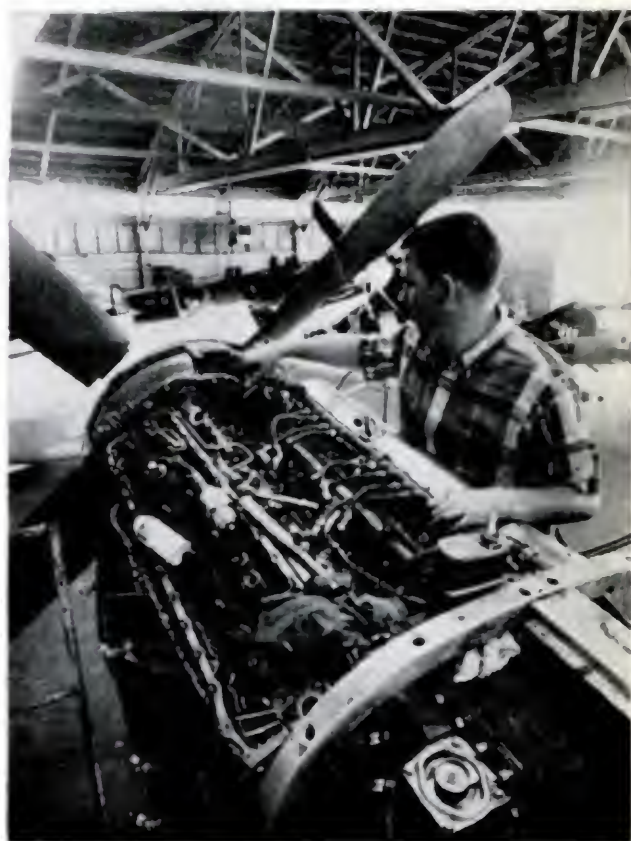
can pack 4000 pounds of ordnance, including six .50-cal. machine guns. Some of these conversions are actually reconversions. Many of the P-51s had been outfitted as racing planes.

The T-28, originally a Navy trainer, will have a 1425-hp engine instead of the original 800-hp plant. Other modifications include armor plating for the cockpit area, self-sealing fuel tanks, and strengthening of the landing gear and wing positions for machine gun rocket pods.

The conversions are being made in most cases by shops which specialized in converting American planes for foreign air forces, principally in South America, or, in the case of the P-51, for racing purposes or air shows.

Hamilton Engineering Co. in Tucson, Ariz., is overhauling old A-26s, as is On Mark Engineering Co. in Van Nuys,

T-28 TRAINERS are being refitted for combat duty on assembly line at North American-Rockwell plant



P-51 MUSTANGS, World War II vets, are beefed up (above) and put in combat colors (above, left)



BEFORE: A-26 Marauders, forlorn and partially dismantled, await shipment to factory for conversion. Some will be used for parts

BIGGER ENGINES are major changes on most of the reconverted airplanes

Calif. Cavalier Aircraft Corp. of Sarasota, Fla., which is known for its civilian versions of the P-51s, is also re-converting some of those World War II favorites for combat. In addition, Aero Sport at San Bernardino, Calif., is redoing the Mustang. The T-28, unlike the others, is being redone by its original maker, North American (now North American-Rockwell) at Columbus, Ohio, on what is probably the largest assembly line for this sort of rebirth.

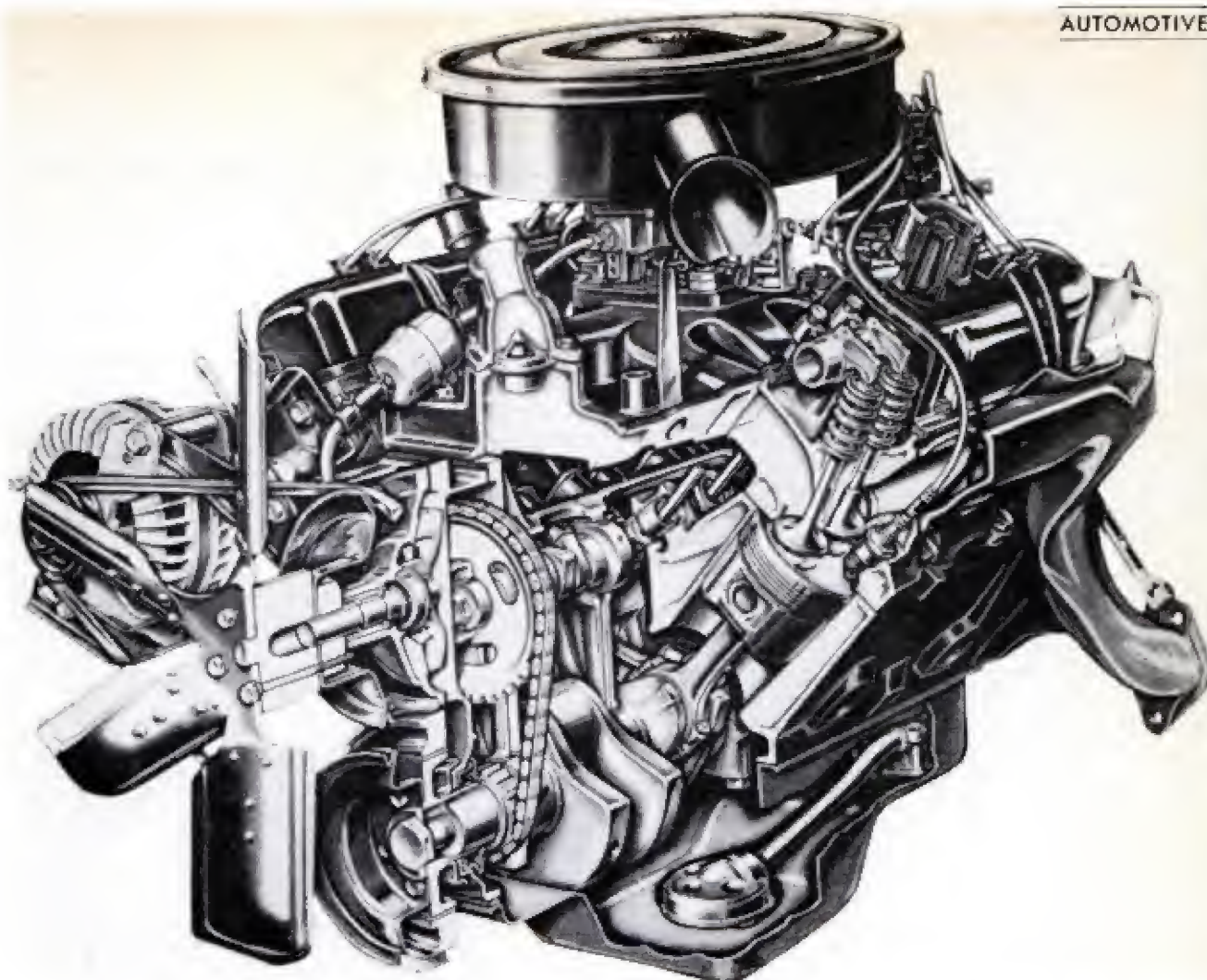
The North American assembly lines may become even busier if a new ver-

sion of the P-51, the Mustang 3, is accepted by the Air Force. Cavalier Aircraft, which recently demonstrated a prototype before USAF officers, proposes construction of 2000 new Mustang 3s. The plane, with an elongated nose housing a Rolls-Royce Dart turbo-prop engine, would have a maximum speed of 470 knots.

The general feeling among companies that are refurbishing the old birds is that business will get better. As they point out: "Half the battles of World War III are being fought with World War II aircraft." ★ ★ ★

AFTER: Reconverted A-26 Marauder, all shined up and ready to fly, rests on a ramp before its test flight





How Far Can We Go With The Piston Engine?

Slick turbine, electric and steam cars may be getting all the headlines, but lots of improvements are ahead for the internal combustion four-stroker

By ROGER HUNTINGTON

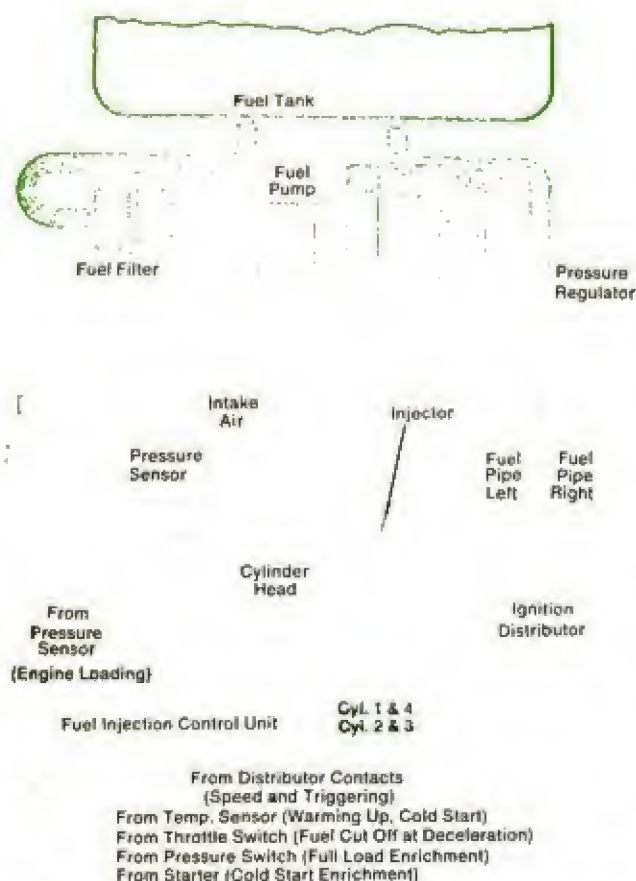
Technical Art by Fred Wolff

AN EARLY DEATH for the age-old internal combustion piston engine is the prediction of some people. They say the exhaust can't be cleaned up enough to meet future air-pollution and antismog laws and that we'll be running around with batteries, steam, fuel cells and atomic engines in another ten years.

Well, Detroit doesn't think so. Auto industry engineers are confident that exhausts *can* be cleaned up substantially. Furthermore, they feel they can

radically improve the performance, economy and durability of passenger car engines in the next ten years—within this framework of cleaner exhaust. But it will take a lot of hard work and money. The old piston engine that's been powering the world's cars and trucks for over 70 years is not dead by any means!

It's no secret that the conventional automotive piston engine as we know it today has some glaring, weak spots that need attention. The engineers know



FUEL INJECTION: This setup already in use on the VW 1600 reduces fuel consumption, exhaust pollution

how to solve these problems, but in most cases they're not doing it because the solution involves hardware that costs too much money to put on millions of engines as standard equipment. However these improvements *will* gradually come in the next few years. Here are just a few of these weaknesses we have now—and solutions you can look for in the future:

● *Uneven Fuel/Air Mixture Distribution Between Cylinders.* With a carburetor setting in the center of a manifold, feeding fuel to the cylinders through long, curvy passages, it's impossible to get exactly equal amounts of fuel and air to each cylinder. Some cylinders run a little rich, while others run lean. And the worst part is that the carburetor itself must be jetted rich enough to keep the leanest cylinder from misfiring. This wastes gas, and the engine doesn't respond as quickly as it could when you punch the throttle because the extra fuel has to bounce around through 10 or 12 inches of pipe between the carb and cylinders!

All these problems can be solved

with fuel injection. Just squirt the fuel into the intake port, right next to the valve—or even directly into the cylinder. It's done with a special injector pump and a system of pipes and nozzles to each individual cylinder. There's no carburetor. Only pure air goes through the manifold. In this way you get exactly equal amounts of fuel to each cylinder. And you get it instantaneously when you punch the accelerator. You even save a little gas because the overall ratio of fuel to air can be a bit leaner without misfiring. And—very important—this leaner mix reduces exhaust pollution. All internal combustion engines will have fuel injection someday.

● *Ignition Point Wear and Timing Loss.* The breaker points in your dis-



PULSE DISTRIBUTOR triggers spark magnetically; no points and rotor to wear out, timing stays set

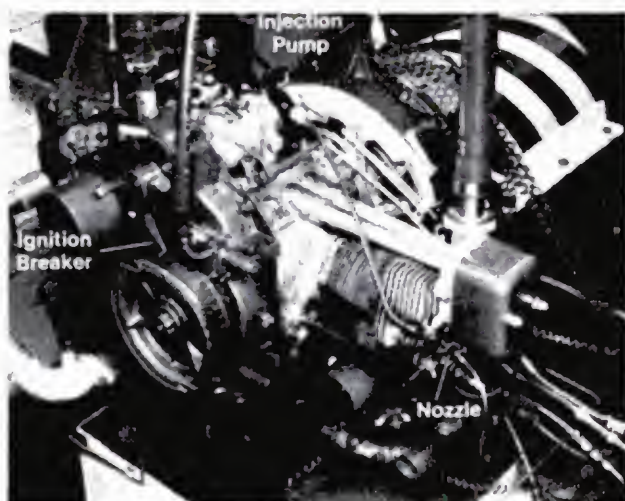


CAPACITOR DISCHARGE ignition system builds up high voltage for firing sparkplugs, prevents fouling

tributor that open and close to trigger the sparkplugs suffer fast wear and corrosion because of heat and arcing. This can cause hard starting, rough running and misfiring within 10,000 miles or less. Also, the little plastic block that rubs on the rotor cam to open and close the points will gradually wear down and cause the spark timing to slip back. Point wear and timing loss cause the engine to lose pep and power, and use more gas. And they can happen in less than a thousand miles after you

● **Fast Wear and Fouling of Sparkplugs.** Sparkplugs are about the weakest point in an engine. They pit and corrode, misfire, get fouled up with soot and lead deposits. A new set doesn't give top performance for more than 500 miles. There just isn't enough energy in a conventional ignition coil to fire the plug with all the deposits on the tip.

The best way to get that tremendous blast of spark energy is with a "capacitor discharge" circuit. Instead of feed-



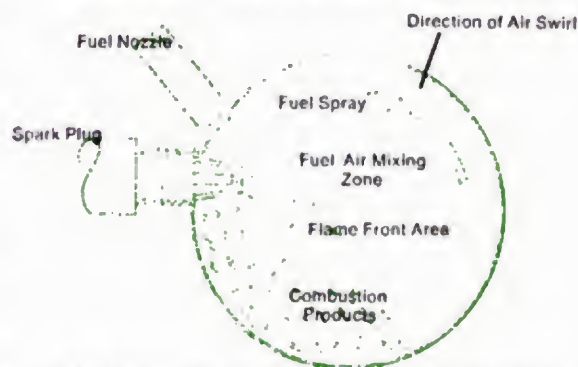
STRATIFIED-CHARGE COMBUSTION PROCESS is precision burning of fuel in a specially designed combustion chamber. Using fuel injection and a piston head configuration that induces an air swirl in the combustion chamber, fuel and air are mixed in exact proportions and the fuel charge is in the right place at the right time for the best burning. The result is greater fuel economy, less pollution and the ability to burn inexpensive low-octane fuel at high compression ratios with no knock. Texaco's adaptation of the principle is currently being researched in its experimental engine shown above. Texaco's research is only one attempt at the best stratified-charge design. Automakers are working on it, too

install new points and adjust the timing. These conditions are a chief cause of performance loss in passenger cars.

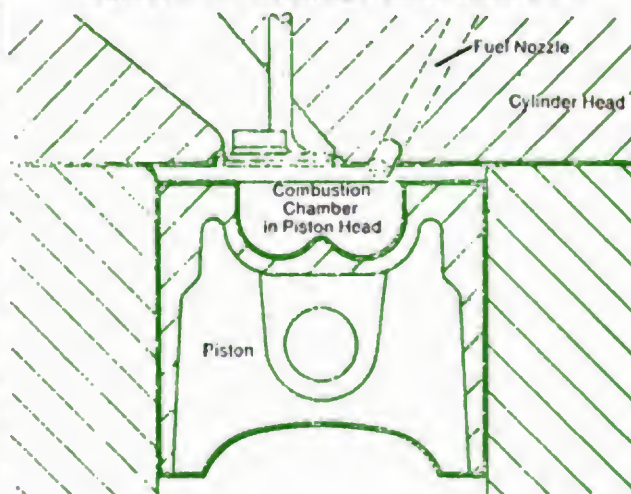
Detroit knows how to get rid of breaker points altogether: Use a little magnetic rotor and pickup in the distributor to trigger the spark by a magnetic pulse. No rubbing parts, nothing to wear out, lasts forever, timing stays where you set it. Only catch is that it takes an electronic circuit to amplify the tiny magnetic spike signal to charge the coil. Too much money now; someday the price will be right.

JANUARY 1969

TEXACO COMBUSTION PROCESS



COMBUSTION CHAMBER CONFIGURATION



ing 12 volts of battery current into the coil, we use this current to "pump up" a capacitor or condenser—much like pumping air into a balloon. A capacitor stores electrical energy. When we trigger the capacitor it blasts up to 400 volts into the coil, and we get a quick-rising surge of up to 30,000 volts at the sparkplug. The plug can't help but fire with this kind of kick. The tip can be partially burned away, pitted, coated with deposits, even soaked with oil. The spark jumps anyway. And, of course, the plugs last and last. There's no need



COLD-AIR SCOOPS are on some cars now. Cold air rammed into carb means more engine power output

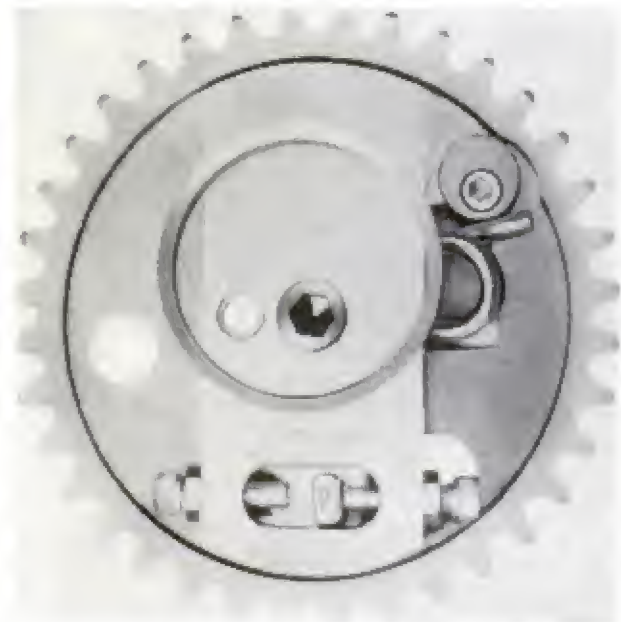
to change them. Maybe every three years, so they don't fall apart!

● *Can't Burn a Lean Fuel Mixture.* A conventional automotive piston engine can't burn a really lean fuel/air mixture because there's not enough gasoline right around the sparkplug to ignite. We need at least one part of fuel to every 15 parts of air to get the fire going. If we could somehow cluster the bulk of the fuel around the plug just before ignition, we could burn much leaner mixtures—and maybe get

another 10 or 15 miles out of a gallon.

One answer is the "stratified charge" engine. There are various forms but the principle is to inject the fuel directly into the cylinder near the sparkplug. Then induce a swirling motion in the air in the cylinder, so the fuel is swept right to the plug. The flame rather stands still while the fuel is fed to it. Sure, the idea is complicated and expensive, but these stratified charge designs show fantastically low fuel consumption—and you can burn cheap, low-octane fuels at high-compression ratios without knock.

Detroit automakers are getting more and more interested. Ford, for one, is

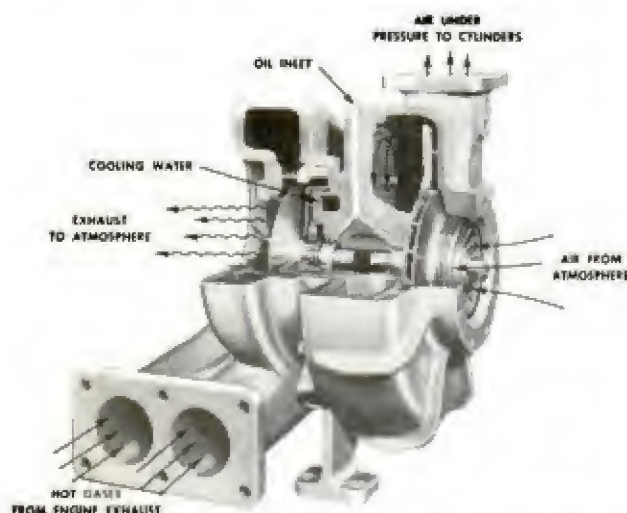


VARIABLE VALVE TIMING instead of preset. It will make possible smooth running at every rpm

refining an FCP engine (Ford Combustion Process) for eventual production.

● *Wasted Exhaust Energy.* At least one-third of the heat energy in the gasoline you burn is blown out the exhaust pipe—wasted. Engineers have been looking for a practical way to recover some of that energy for 50 years.

The best answer right now is the "turbo-supercharger." Here we have the waste exhaust gases driving a turbine, which in turn drives a tiny rotary compressor that forces the fuel/air mixture into the cylinders under pressure. It works like crazy. The "turbo-supercharger" unit weighs about 20 or

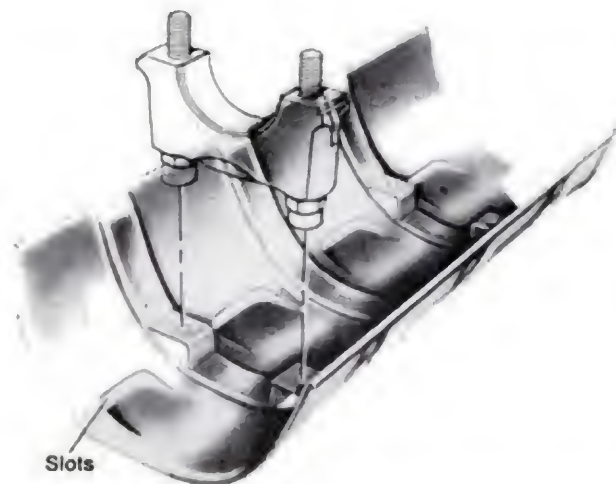


TURBOCHARGER utilizes wasted exhaust gases to drive turbine and force air into the engine cylinders

30 pounds, is the size of a watermelon and pumps up to 30 pounds per square inch pressure at 100,000 revolutions per minute or more! You can double the horsepower of a conventional engine with no trouble. In effect you're putting waste exhaust gas to work to "supercharge" the intake side. And turbochargers are not exotic laboratory curiosities these days. They're widely used on diesel trucks, tractors and trains. And, you'll recall that Bobby Unser, driving a turbocharged Offenhauser won the Indianapolis race last year to the dismay of three drivers in exotic turbine-powered cars.

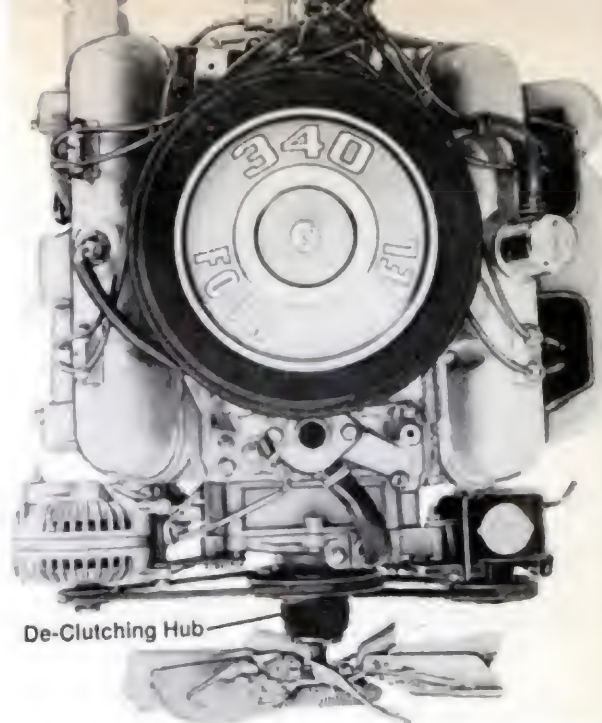
It should be just a matter of time before your family car has one, especially since it's one good way to increase performance without a dirty exhaust.

● *Excessive Exhaust Restriction.* Most standard American passenger cars have excessively restrictive exhaust systems that generate a lot of "back pressure," and choke off the engine power. It's common to lose 30 to 40 hp. And it's no trick to solve the problem: Streamline exhaust manifolds and dual tailpipes and mufflers. Some of our high-performance models like the GTO and Corvette have beautiful exhaust systems. But Detroit isn't buying them for standard cars. They say streamlined manifolds cost too much and take up too much space, and dual exhausts corrode and rust out too fast. There's not enough hot exhaust gas going through



CRANKCASE Baffle fits between crankshaft and oil pan to eliminate churning. Slots let the oil run back

JANUARY 1969



DECLUTCHING HUB disconnects fan from engine at high speeds, saving horsepower needed to drive it

them at low speeds to vaporize and carry away moisture and acids.

We think this picture will change. Engineers are doing more work on manifold design these days. And new low-cost anticorrosion coatings and steel alloys will solve the rust-out problem.

● *Power Loss From Hot Intake Air.* Your engine breathes hot air under the hood of your car. And we all know that hot air is thinner than cold air and that an engine can develop more power on the heavier cold air. In fact you can pick up 10 or 15 horses just by scooping cool outside air into your carburetor. Some of the latest high-performance models from Detroit have this new "ram-air" feature, using hood scoops or air tubes from the front. We expect to see a lot more of this. One reason is that some of the new government-required exhaust emission control systems are pumping hot air to the carburetor at low speeds. It's easy to rig a valve deflecting cold air to the carb when you punch the throttle wide open. Mild to wild in half a second!

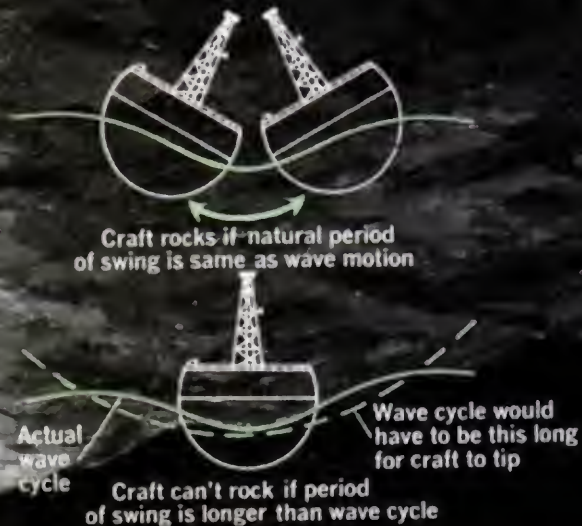
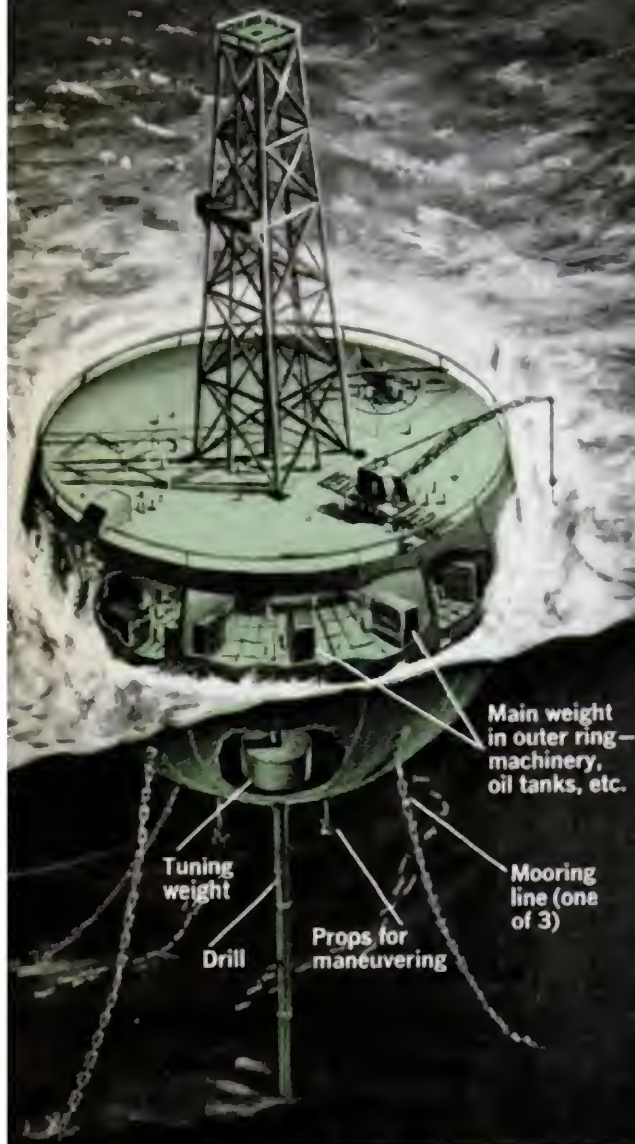
● *Compromise Valve Timing.* Timing of intake and exhaust valves in relation to the suction and exhaust piston strokes has to be a compromise to get an engine to run smoothly over a broad

[\(Please turn to page 222\)](#)

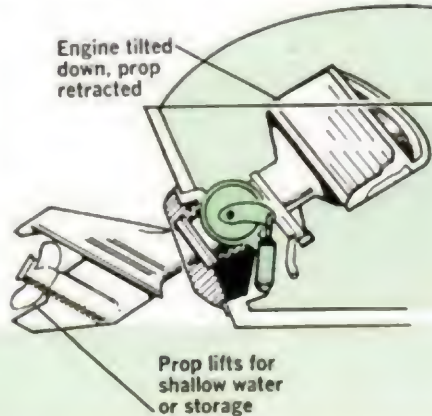
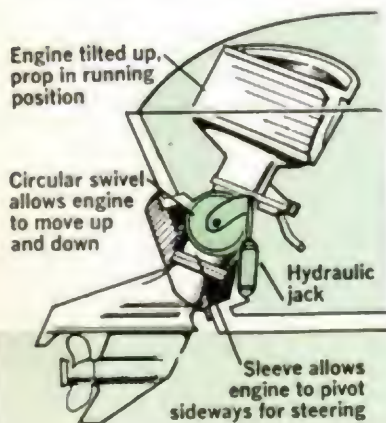
Just patented

PM'S PICK OF THE NEW INVENTIONS

Prepared in cooperation with Roger S. Shashoua, Director, International Inventors Association, Inc.



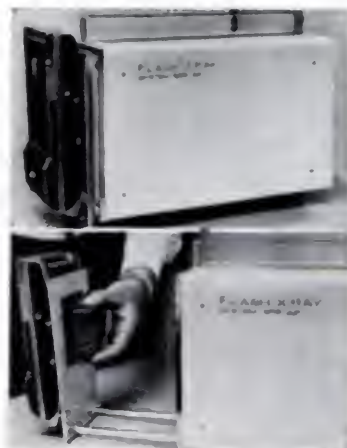
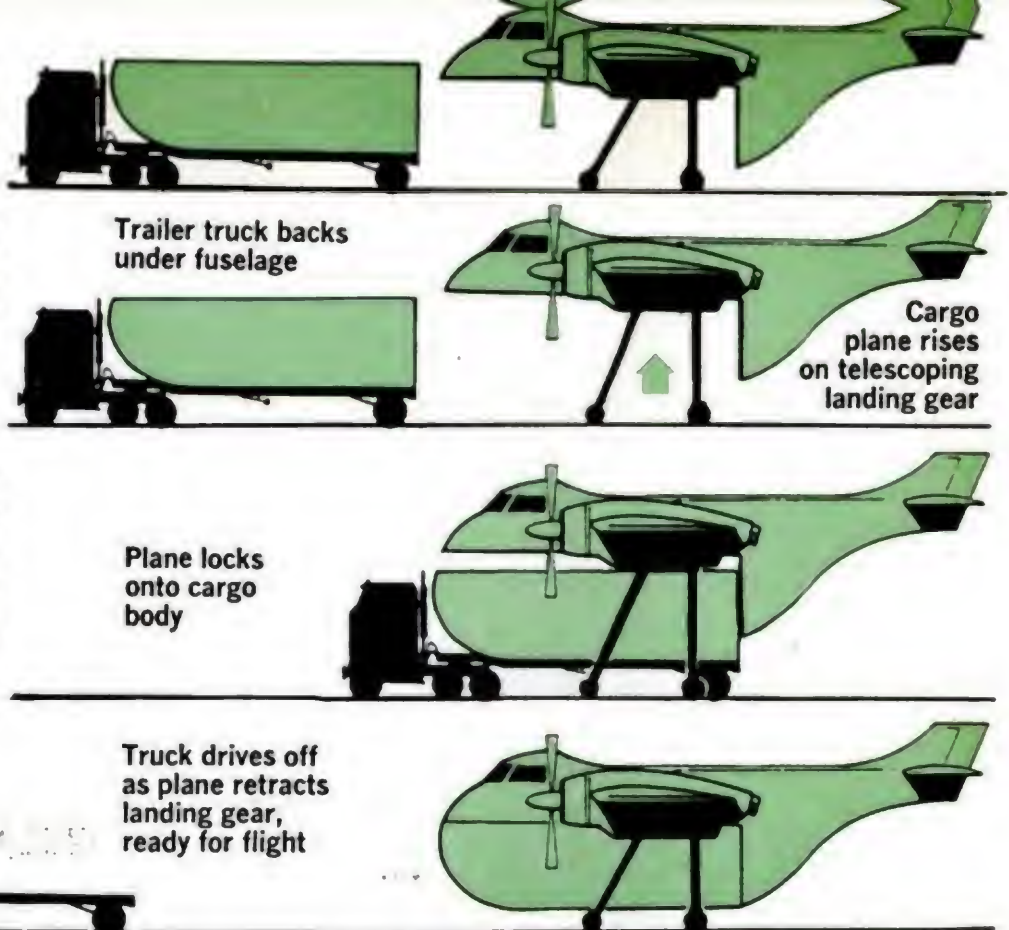
1. STORM-TOSSED WAVES can't rock this offshore oil-drilling rig no matter how rough they get. The secret is that the ball, acting like a swinging pendulum in the water, can be tuned to oscillate only at a certain frequency—just as a metronome is tuned to oscillate at a desired musical tempo. All waves have frequencies that fall within a fairly narrow range. The ball is tuned to a longer swing rate than is found in natural wave motion and thus can't be rocked by the waves. Providing a stable platform reduces drill breakage and eliminates the danger of capsizing—a serious hazard in storms. The tuning weight is placed at the bottom of the ball and is adjusted to provide the exact swing rate desired. Small motor-driven props permit the rig to maneuver under its own power. The idea can also be applied to floating factories, such as fish-canning plants.



2. AN OUTBOARD ENGINE becomes an inboard powerplant with this through-the-transom pivot arrangement. The idea is to provide the advantages of an outdrive with a simpler installation. Enclosing the outboard offers greater protection in bad weather, gives the trim look of a decked-over inboard, and makes the engine easier to reach for maintenance. Like an outdrive, the two-way swivel lets the prop swing sideways for steering and tilt up and down for running in shallow water.

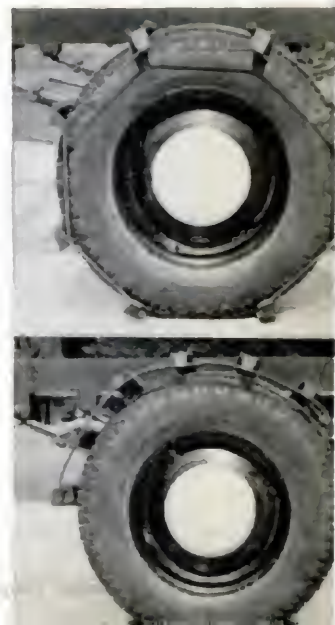
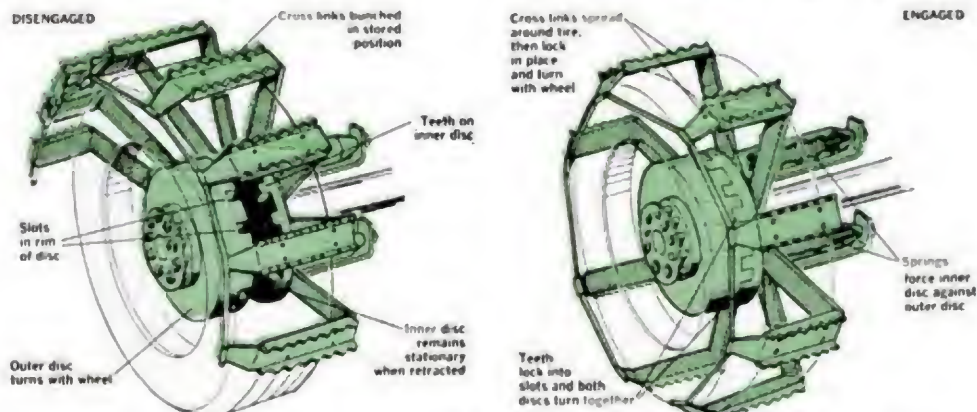
Inventors of the items shown on these pages are as follows: 1. John F. Holmes, Sanders Associates, Inc., 95 Canal St., Nashua, N. H.; 2. Elmer Carl Kiekhaefer, Winter Haven, Fla. (No. 3,382,839); 3. Robert H. Reno, 133 Columbia Turnpike, Rensselaer, N. Y. (No. 3,361,396); 4. Hivotronic, Ltd., Wella Rd., Basingstoke, Hampshire, England; 5. J. W. Putt,

3. SWITCHING CARGO from a trailer truck to an airplane takes only a few minutes with this system. The truck's body is actually a detachable cargo pod shaped to form the lower half of the plane's fuselage. The plane is jacked up on telescoping landing gear, the truck backs under it, and the pod is bolted on. The truck drives off empty, and the plane is ready for flight. With the system, planes could switch cargoes quickly without waiting for them to be unloaded. The pods could also be transported via railroad on flatcars and in container ships



4. YOU CAN MAKE AN X-RAY as fast as you can take a Polaroid picture with the clever device at left. In fact, that's exactly how the system works. X-ray images produced inside the machine are recorded by a standard Polaroid camera held in a slide-out rack at the end. In 20 seconds, out comes a finished print of the X-ray. The sample print at near left shows the insides of a tiny electronic switch embedded in plastic and normally invisible. The small, portable unit, weighing only 25 pounds, is designed for both medical and industrial uses where there is a real demand for X-rays quickly

5. YOU DON'T EVEN HAVE TO STOP to put on the "instant" tire chains below. In good weather, spiked cross links are held above the wheel on a stationary disc. In snow, you press a button and springs force the disc against the wheel hub. Teeth on the disc catch in slots in the hub and the disc turns with the wheel. The cross links spread around the tire until they're evenly spaced, then lock to give traction



Non-Skid, Inc., 1730 Wyoming Ave., Forty Port, Pa. Readers wishing to bring new inventions to the attention of Roger S. Shashoua can reach him at the International Inventors Assn., Inc., 680 Fifth Ave., New York, N. Y. 10019.



Flying the English

England's huge new Hovercraft skims smoothly above the choppy waters, carrying 30 cars and 250 passengers to France and back at up to 80 knots

By J. A. MAXTONE-GRAHAM

"THE FASTEST SHIP in the air." That's what they're calling Britain's newest over-water vehicle that whooshes cars and passengers 26 nautical miles to France at twice the speed of a destroyer.

Early in August, I stood below the white cliffs of Dover on a newly paved area beside the sea, within the harbor walls. I climbed the aircraft-style steps into an aircraft-style cabin filled with rows of aircraft-style seats. But there were no safety belts, and I could continue to smoke.

Soon, four 19-foot four-bladed propellers churned to life atop a weird, blunt-nosed hull. Then, with engines revved to full power, a great blast of air thrust downward at the beach. I felt the craft rise sedately to cruising altitude—all of seven feet! Half a minute later, she was moving seaward down a ramp at 20 knots. Once past the narrow harbor entrance, the pilot increased the pitch of the propellers; suddenly biting the air, they pushed our speed up to a dramatic 50.

Within 35 minutes, we hundred pas-



Channel: Altitude 7 Feet

sengers were stepping down to the French beach at Boulogne. A hydraulically controlled ramp lowered smoothly to the ground, and 20 cars rolled out. By normal steamship, the whole process would have taken nearly three hours.

The British Hovercraft Corp.'s SR.N4 is by far the largest, fastest and most reliable air-cushion vehicle yet made. One hundred tons of aluminum alloy and rubber, it towers 45 feet into the air, and would overflow a tennis court; its 130-foot length makes it fit to breast 12-foot waves. It's driven by four giant Marine Proteus Rolls-Royce engines, each developing 3400 horsepower—and even if two failed, the craft could still hover and travel slowly. Each of



HOVERCRAFT PASSENGERS board ship from dry ramp via airline-style stairs for ferry trip to France



CARS, TOO, are loaded aboard 100-ton Hovercraft. Huge ship can carry 30 of them for each crossing



AWAY WE GO! *Princess Margaret* rises on air cushion, floats down ramp, and heads across Channel

the engines drives one of the variable-pitch propellers for propulsion, plus a 12-bladed centrifugal fan for lift. With a 200-mile range and a top speed of nearly 80 knots, it is scheduled to make 12 cross-channel trips a day with a 50-ton payload: 30 cars and 250 passengers. The SR.N4 has brought Hovercraft out of the realm of experimental playthings and into the true world of commerce.



250 PASSENGERS sit in comfort on airline-style seats. Smooth ride keeps seasickness to a minimum

Says the British Hovercraft Corp., which built it: "William the Conqueror needed 700 ships to bring his 10,000 invaders from France in two days. In that much time we could have moved them all with one SR.N4."

To watch *Princess Margaret* skimming over the wavetops of the choppy English Channel, it seems hard to realize that 11 years ago not even the

PILOT, COPILOT sit in airline-style cockpit. One handles horizontal movements, the other lift and thrust





JOURNEY'S END. Hovercraft rests, slightly "squashed" on slanted ramp in France. Turnaround time, 25 minutes

smallest Hovercraft had been built. It was only in the mid-'50s that Christopher Cockerell experimented with a coffee can, a pet-food can and a hair dryer to make the first hovering device. It's as if the Model-T Ford were running a decade after the invention of the wheel. Like the iron horse, the horseless carriage and the flying machine, the Hovercraft was easily dismissed by traditionalists as a passing fad that could never have any lasting or commercial application; yet, designers are already toying with plans for colossal 5000-ton super-Hovercraft capable of taking you—and your car—across the Atlantic in 24 hours for under \$200.

On my outward trip from Dover, the Channel was no more than choppy. All the same, the six men employed as "car-lashers" put a firm strap from each car wheel to steel rings on the deck. The full 50 knots were maintained all the way. I found it gently and predictably bumpy, as if riding in an unsprung farm trailer along a dirt road, or riding at a trot on a horse. There is no bar service for this reason, although pretty "purserettes" in trim blue airline-style uniforms will sell you duty-free bottles and cigarets.

As spray hammered on the 2½ by 3-foot windows, we streaked impudently

(Please turn to page 204)

PRINCESS MARGARET is not immune to weather. Huge wave last fall tore 8-foot hole in bow, 12-foot hole in skirt. Service was suspended for repairs



MORE EXCITEMENT THAN MEETS THE EYE



Those Small

Here are five imports that remind us motoring can be fun. Lined up from left: Saab De Luxe, BMW 2002, Fiat 124 Sport Coupe, Ford Cortina GT and Datsun PL 510.

By **ALEX MARKOVICH**

Photos by Stanley Rosenthal

THE KID in the chrome-encrusted, ego-boosting V8 glances scornfully at your little foreign sedan and yawns. You pretend you're watching something else, but sneakily you ease the stubby shift lever into first.

Green light. You kick the gas, pop the clutch and smile your cocky Walter Mitty smile. Yeow-w-w—the little Four winds up tight. The kid, caught unawares, eats dust.

That's what these hot new sports sedans from Europe and Asia are all about. Camouflaged as somewhat flabby, asthmatic economy cars, they offer the comfort, passenger room and milquetoast appearance of a sedan—plus the performance of a sports roadster.

If you've had it with the big stuff, step right up and try a gen-yoo-wine



Sporty Sedans



BMW LEANS HARD (opposite, top). Sway bars in later 2002s correct this. The carb needed adjustment; on hard left turns, engine missed. Fiat (opposite, middle) corners the flattest. Well-located live rear axle takes any kind of road. Saab (opposite, bottom) will switch from understeer to oversteer by just letting up on gas. Front-wheel drive is stable on icy, snowy road surfaces. Cortina GT (top) leans hard in corners. Suspension is soft and front-end plowing limits car's maneuverability. Datsun (above) handling is respectable but not sensational. Skimpy bucket seats give no lateral support in hard turns, making it hard to reach car's full handling potential

imported Q-ship. Absolutely guaranteed to cure everything that ails you. But beware of imitations with racy names, gaudy stripes, chicken hearts.

To separate the sheep from the wolves, we wrung out five popular sports sedans, all roughly in the \$2000 to \$3000 range. The list reads like a UN roll call: from Germany, the BMW 2002; Italy, the Fiat 124 Sport Coupe; Sweden, the Saab De Luxe; England, the Ford Cortina GT; Japan, the Datsun PL 510.

Unfortunately, a few potent sedans are missing. The Opel Rallye from Germany probably would have made a good showing, but we couldn't get one in time for our tests. And race-winning machines such as the Lotus-Cortina no longer can be sold in this country; they're victims of antipollution laws.

BMW 2002

Our most expensive test car was the BMW. Though the ads say \$2847, all cars sold here come with \$161 worth of "options," including tachometer, front and rear sway bars, reclining seats, and vinyl upholstery; these bring the bill up to \$3008.

Though not revolutionary, styling is



clean and tasteful. All body panels fit just so and the paintwork is flawless.

The interior would do credit to a car costing \$1000 more. Everything is thickly padded. The underside of the instrument panel is covered to shield your sensibilities from the sight of dangling wires. Wall-to-wall carpeting is standard.

To hold assorted clutter there's a long package tray in the instrument panel, a glovebox that shuts like the gates of Fort Knox, a large storage bin over the floor hump (full of optional radio), and map pockets in the seat backs. The trunk, while smallest of the test cars, holds a respectable 9.5 cu. ft.

Smack in front of the driver are the big, round speedometer and tachometer, plus fuel and coolant-temperature gauges. Unfortunately, warning lights replace the oil-pressure gauge and ammeter, and the temperature gauge has no numbers.

Front seats fit anyone from an orangutan to the Jolly Green Giant. Headroom is ample front and rear, but adjusting the front seat for a tall driver makes the rear impossible for long trips.

The cabin, with glass rivaling that of a window factory, gives perfect visibility in all directions. Grab handles sprout from the doors and headliner, but they're rarely needed—at least in front. The firm, comfortable bucket seats hold everyone in place when the car is flung into corners with wild abandon (a caper that's hard to resist with the BMW).

The suspension probably is the car's

(Please turn to page 206)

BRAKING TESTS for the five sporty sedans were revealing. From top to bottom, photos indicate results for the cars as follows: Braking distances for such a sporting car as the BMW 2002 were disappointing. All the stops were essentially straight, however. Brakes of Fiat's 124 Sport Coupe fared well in the fade tests. The pedal's spongy feel did not seem to affect efficiency. Saab's brakes gave good braking distances after three panic stops, but there was considerable loss of directional stability. With the Ford Cortina GT, hard braking resulted in extreme nosediving. Stopping distances and directional stability proved fair. Best brakes of all come in Japan's low-priced Datsun PL 510. Repeated panic stops caused no noticeable fading

POPULAR MECHANICS



BMW 2002



FIAT 124



SAAB DE LUXE



CORTINA GT

IMPORT'S INTERIORS all have bucket seats, but differ on many counts. BMW (top, above) has clock as center instrument, but tachometer is substituted in newer models. Steering wheel is too big and too high. Bucket seats have fully reclining feature, which is standard on BMWs coming into U.S. In the Saab (above), high cowl cuts visibility, especially for shorter drivers. Front-wheel drive gives flat floor. Fiat (top right), has immaculately designed cockpit. Gauges are set in wood-grain panel and controls are perfectly placed. Bucket seats are great. Cortina interior (right, middle), has nicely shaped bucket seats, but pedal placement is poor. Full array of round gauges is set in the handsome dash. Datsun interior (right), was executed with economy in mind. Also, gauges are hard to read: key, handbrake are inconveniently located



DATSUN PL 510

SMALL SPORTY SEDANS—HOW THEY COMPARE

	BMW 2002	FIAT 124 SPORT COUPE	SAAB DE LUXE	CORTINA GT	DATSUN PL 510
Price	\$3,008	\$2,878	\$2,550	\$2,243	\$1,999
Engine type/displacement (cu.ft.)	sohc 4/121.4	dohc 4/87.75	V4/91.4	4/97.5	sohc 4/97.3
Horsepower @ rpm	114 @ 5800	96 @ 6500	73 @ 5000	93 @ 5400	96 @ 5600
Length (in.)	166.5	162	164	168	162.2
Wheelbase (in.)	98.4	95.3	98.0	98.0	95.3
Curb weight (lbs.)	2068	2110	1940	2088	2127
Steering (overall ratio) /turns (lock to lock)	17.6:1/3.5	16.4:1/2.75	14.0:1/2.25	16.4:1/4.25	15.5:1/3.0
Turning circle (ft.)	34.1	36.1	35.0	30.0	31.4
Trunk capacity (cu.ft.)	9.5	9.6	13.0	12.0	11.4

When Radiators Were Regal

Text and Photos by MIKE LAMM

RADIATOR ORNAMENTS used to be to cars what faces are to people. Classic Packards, for example, were recognized by their hood statuary because Packard never stooped to emblazon its name on models of the late '20s and early '30s.

The ornaments had practical beginnings. At one time they housed stubby thermometers called motor meters, but as temperature gauges moved inside, the meters were replaced by graceful, often beautifully sculpted works of art. All but a few were gorgeously proportioned and painstakingly detailed, as these photos taken at Harrah's Auto Museum, Reno, Nev., plainly show.

Hood-ornament art reached its zenith about 40 years ago. Toward the mid-'30s abstraction began to set in and art directors rather than artists became responsible for hood ornament design. Ornaments became more clinical, less classical, reaching their nadir just after World War II. Soon, the plastic-cum-anodized aluminum lumps that became standard at the time spelled the final doom of the once magnificent radiator art.

With the recent advent of formal safety standards, the hood ornament all but disappeared. ★★★





1913 MERCER



1928 ROLLAND PILAIN



1931 BUGATTI ROYALE



1927 STUTZ BLACKHAWK



1925 MINERVA



1932 LINCOLN KB



1929 KISSEL WHITE



1927 DUESENBERG MODEL X



1928 FRANKLIN



1909 MODEL T



1930 DU PONT ROYAL



1913 COEY FLYER



1930 PACKARD



1936 HISPANO-SUIZA TYPE K6



1938 PHANTOM III



Talking doll helps analyze children's problems

Baby Belinda, a talking doll, helps therapists at Dublin Children's Hospital find causes of speech and behavior problems. While watching the child via a see-through mirror (above), a therapist talks to the child by means of an amplifier in the doll's head (far right). Therapists find that children are relaxed and more responsive when playing with toys.



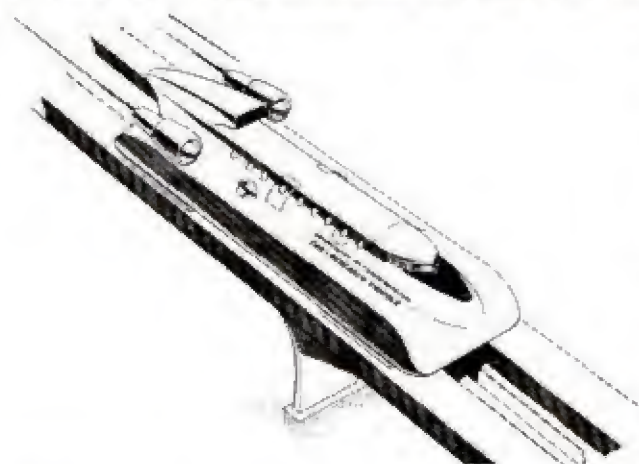
Breath control

By puffing into plastic tubes, quadriplegic John Eygenraam can control his motorized wheelchair. Motors on the rear wheels are connected to sensitive switches that are, in turn, controlled by the air coming through the plastic tubes. The chair was made in the physics dept. of West Australia University.



Automatic pipe inspector

This battery-powered X-ray machine can inspect the welds in a mile of pipeline before its nickel cadmium batteries need recharging. A remote-control device stops the machine at the joint to be X-rayed. It then emits a 360° beam, exposing a film strip wrapped around the weld. Flaws show up on the film.



300-mph trains

A 300-mph air-cushion train might look like one of these two designs. The U.S. Dept. of Transportation has awarded contracts for a preliminary design study for a Tracked Air-Cushion Research Vehicle to General Electric (top drawing) and Grumman (bottom).

JANUARY 1969

Well done

Capt. Grant Callin leaves a research oven at Wright-Patterson Air Force Base where he and other volunteers are exposed to temperatures up to 500°F. as part of space-flight research. They wear only light flying clothes, and can tolerate 500° for about six minutes.

113



His Office Is Under the Sea

Lockheed's Donald Saner belongs to a new and select breed of submariners to whom the ocean depths are not a battleground but a frontier that should be explored and developed.

By **NORMAN SKLAREWITZ**
Photos by James Pickerell

LIKE MANY GUYS before him, Donald Saner sweated out retirement from the Navy. He enlisted right after high school when he was just 18 and worked up through the ranks to lieutenant (j.g.).

Still, Don was a submariner—and what does a veteran of 20 years in the undersea service do in civilian life?

That's easy: He becomes a civilian submariner.

Don Saner today is a pilot with *Deep Quest*, the deep-diving submarine built by Lockheed Missiles and Space Co., and operated out of its ocean laboratory in San Diego. It's a challenging and fast-growing profession that involves exploring the secrets of the sea and paving the way for new

DON SANER (with telephone, left and right) guides *Deep Quest* as it is lowered to water level by its mother ship, *Transquest*, then floats on surface before making dive





INSIDE SUB Saner checks control panel in pre-dive preparations. He was aboard during its record dive

traffic like any other Californian. By 7:30 a.m., he swings through a gate and parks in front of operational headquarters. It's the kind of spot in which an ex-Navyman feels at home. The blue waters of San Diego Bay sparkle a few steps away. Looming gray and imposing in the distance are anchored ships of the U.S. First Fleet.

Inside the two-story ops building are a half-dozen unimposing offices. Each member of the *Deep Quest* crew has two jobs, one during dives, the other ashore. Larry Shumaker, for example, has made every one of the sub's 24 shakedown dives, all as its commander. When the sub is in port, he's responsible for all its maintenance and systems repairs.



DEEP QUEST floating near surface on day it set record. Diver is making final inspection before it descends

industrial and military applications of underwater craft.

For now, though, being a civilian submariner is an exclusive thing. There are just 32 members of the Deep Submersible Pilots Assn. In the whole world, there are probably no more than 30 civilian subs.

Being part of this exciting new world, however, is still a job. So Don Saner pushes his Rambler station wagon through early morning freeway

Glenn Minard is chief pilot during dives and the man responsible for structural and mechanical operations of the sub.

Bob Worthington, a pilot, is also charged with planning and operations.

Don Saner is pilot during dives and, ashore, is the man in charge of the sub's electrical systems.

The entire staff is made up of 18 men under P. E. "Pete" Summers, program manager, and it includes Dave



DON SANER guides *Deep Quest* from above as diver checks connection around and beneath deep-diving sub

McCafferty, skipper of the 108-foot *Transquest* support ship, technicians and even a seagoing chef.

During its first series of two dozen dives, *Deep Quest* was tested to see how its motors, life-support systems and on-board equipment worked. The tests included a dive which took the sub down to 8310 feet, the deepest ever made by a commercial true submarine.

But when we visited there these trial runs had ended. It's since been made into a sub-for-hire, available on contract to industry and government, and

Lockheed sees a variety of uses for its whale-shaped craft. It can take core samples from the ocean floor for scientific or ocean mining or drilling operations. For equipment makers, it can take advanced underwater acoustic systems and equipment down for research studies or test checkouts. And the military is interested in *Deep Quest* to train aquanauts and to develop advanced underwater search and recovery techniques.

There's almost no such thing as an

(Please turn to page 215)

TRANSQUEST carries *Deep Quest* out to diving site where it will lower sub to water level on its elevator





Those Wonderful Brothers Wood



GLEN AND LEONARD WOOD time every lap of their car, work each race according to plan

Auto racing's most dedicated team has fielded the last five winners of the Riverside 500. This month Glen & Co. will be shooting for a sixth straight

By BILL KILPATRICK, Auto Editor

Photos by Stanley Rosenthal

HERE'S GLEN WOOD, race-car owner, the-man-in-charge, the head-knocker—early 40s, wiry, weathered, looking like every drover on every TV Western you've ever seen—policing his pit area.

When the chairman of the board stoops to pick up butts and stray candy wrappers, you realize you're looking at a man who takes his career seriously.

Here's Leonard Wood, race-car brood hen, top wrench, engine genius, micrometers for fingers—early 30s, also wiry, looking like a bespectacled seminarian—scrambling up under an upraised hood.

To observe his absolute concentration as he squats atop an engine and gets right down there to the serious business of carburetor adjustment is to understand you're looking at a man dedicated to his work.

These two men—Glen ("Don't know what happened to that other 'n'. Guess I dropped it when I started signing autographs.") and Leonard Wood, from a nice little "down home" town called Stuart, Va.—are the backbone and full-time personnel of a colorful and highly successful enterprise known as the Wood Brothers, one of the winningest teams in auto-racing history. Cars prepped and crewed by the Woods have won the big 500-milers at Indianapolis (Jimmy Clark in '65), Daytona, Atlanta, Rockingham, Riverside, you-name-it. They've also fielded winners at scores of smaller tracks in the South, home and hotbed of stock-car racing.

At Riverside, their cars have won the annual 500-mile stock-car race five times in a row. This month, working a car driven by either Dan Gurney (who has won the race five times, four in a Woods Brothers car; their other winner was Parnelli Jones) or Cale Yarborough, perhaps a car for each, they'll be seeking their sixth straight. Consistency of this sort is impressive and far from a matter of chance, although the brothers gratefully acknowledge an at-least-nodding acquaintance with Lady Luck.

"The harder you work to prepare a car, the better your chances of winning," says Leonard. "But luck has a big part in it, you can be sure of that."

Another big part of the Woods' success is



WOOD BROTHERS work out of modest garage in Stuart, Va. Race car is hauled to tracks via special truck

the great dedication and skill of the rest of the crew—brothers Clay ("He's older," says Glen. "He's even 45!") and Delano (they pronounce it De-lay-no), cousin Ralph Edwards and friend Ken Martin, all of whom are raceday regulars. From time-to-time, depending upon who can get away from his workaday job, other friends—Jim Reed, Jack Kendrick, Grover Adkins—help out.

Dressed alike in fresh, crisp uniform shirts, each of which bears the wearer's name embroidered over the right pocket, and sparkling white ducks, they look like they mean business. To appreciate how much they mean business, you have to watch them work a race. Really watch them.

When a car they're crewing is out on

the track, they watch over it like a mother bird watching a fledgling's first flight. Despite the frenzy and ear-shattering noise of the race itself, they seem able to detect the slightest note change in an engine's roar, the least variation in a car's handling. Not a trick is missed as to what's happening with and to their car at any point.

Glen or Leonard, often both, time each lap, shout the results to Delano, who, in a broad, graceful hand, chalks the appropriate numbers on a large, somewhat battered blackboard he then holds aloft for the driver to read as he flashes by. Ken Martin, in charge of refueling, tends to his gas cans—lining them up just so, carefully placing a protective rag and tin can over the neck of each. Clay and Ralph Edwards see that

GARAGE, neat, quiet and well-laid-out, affords Leonard a time, place to letter driver's name on car door





WOOD BROTHERS are meticulous about small details. Delano mans broom in a pit area before start of race

the impact wrenches, new rubber, tools, jacks—whatever might be needed during a pit stop—are in place and ready to go. Jim Reed does the scoring, methodically records each lap the car makes. Jack Kendrick and Grover Adkins keep the pit area free of clutter, help position the tires and other equipment likely to be used at any given pit stop. All jobs, with the exception of those of Glen and Leonard, are interchangeable, all are performed with a relaxed informality that belies their seriousness.

When Glen passes the word and Delano flashes the driver to make a pit stop, the pace picks up in a blur of activity. Poised, the arms of their trade at-the-ready, they swarm at the car like bees. Each duty is specific and well-rehearsed.

Glen goes over the pit wall first. He darts in front of the still-braking car, heaves against the right front fender to help bring it to a halt. On his heels is Leonard, carrying an impact wrench and the 70-lb. right front wheel and tire. Poor timing on the part of either man means a sore back and a bruised rump.

In back scoot Ralph Edwards, carrying another impact wrench, and Delano, lugging a hydraulic service jack. Clay hops over the wall, twists open the fuel cap, reaches back to grab the right rear tire and wheel. He and Delano have clamped in their teeth short rods upon which are strung several new lug nuts.

Ken Martin, with a hand from Jack Kendrick (or whoever has the duty), goes over the wall hefting one of the big refueling cans. His feet dancing up and down a mile-a-minute, he slings the heavy can around and jams its neck onto the fuel intake pipe. It has to be the closest thing to in-flight refueling to be seen below 30,000 feet.

Delano sets the jack as Leonard and Edwards attack the right side wheels with the impact wrenches. He heaves the car up as the sorely-used rubber falls off. Clay, having brought the right rear tire around, drops it in position, unclamps his teeth to drop the new (and cool!) lugs into the palm of his hand. Delano, the car jacked up, steps toward the front, also releases the lugs

(Please turn to page 218)

ANOTHER RACE OVER, weary Cale Yarborough climbs out of second place car, is greeted by Leonard



The Flying Belt

The "Buck Rogers" belt now has a jet engine that gives it longer range for a whole new variety of missions. Who knows, someday it may even become a commuter's vehicle.



ROCKET BELT (above, in flight) is smaller, with shorter range, than new and bulkier jet belt

Stretches Its Wings

AVIATION

BUCK ROGERS suggested it and Bell Aerosystems produced it, but their rocket belt had a limited burning time and, consequently, a limited range. So Bell switched to a jet engine which now increases its time aloft from seconds to minutes, and its range from feet to miles.

Its military significance is apparent. One man in a jet belt could safely clear a path through a mine field, lay communications lines or flit about as an artillery spotter. Several of them could become airborne infantrymen, spotting and surrounding hapless guerrilla forces.

Civilian applications may be even

more spectacular. Police could use jet belts for riot control, spotting snipers or burglars, or for setting up road-blocks and chasing fleeing criminals.

And the average commuter may, at last, have the long-awaited individual commuting vehicle that would whisk him from his front porch to his office entrance in minutes.

Like the rocket belt, the jet belt is controlled by hand grips which allow the wearer to direct his flight up, down or in any other direction to a maximum of 70 mph. The specially constructed jet engine, one foot in diameter and two feet long, uses two nozzles for thrust. ★★★



JET BELT is strapped to user's harness and rests mainly on hips during flight. Stand supports it on ground. Jet engine is heart of system, giving belt more burning time and longer ranges. It burns ordinary kerosene fuel, the same kind used in airliners. The jet belt is expected to have wide application among both military and civilian users

Trim Tabs: Do They Really Make a Difference?

PM's stopwatch tests, plus a season of cruising, turn up some surprising facts about stern flaps

POWER OF TABS is indicated by wake within normal hull wake

By **ART MIKESELL**

Photos by *Henry Bedlivy*

IF IT WEREN'T FOR the fact that no hull is absolutely perfect, trim tabs probably would never have been invented. As it is, though, adjustable tabs provide the most efficient means of making a good hull perform better under various operating conditions. Here's why.

Any hull is a compromise shape, a combination of design factors put together to meet average requirements for that particular type of boat. A specialized design can come closer to perfection, because the performance requirements are so narrow. With an SK (high-performance ski boat), for instance, the designer can concentrate on quick getaway and speed. He doesn't worry about how the boat will handle in rough water, because nobody in his right mind would take an SK out in heavy seas.

It's the average boat that presents the problems. Survey the people who are going to buy it, and you'll find performance requirements stretching all over the lot. To satisfy everyone, it must have the speed of a three-point hydro, the stability

of a catamaran, the rough-water capability of a dory, the load-carrying ability of a barge and the appealing lines of Raquel Welch. Also, it should be priced within the reach of everyone.

Since a marine architect isn't a magician, the best he can do is mix the various design factors to produce a hull that has a little of all of the above. He may give up a little speed for increased stability, or vice versa, but the result is still a compromise.

Once you buy a boat, you're stuck with a locked-in set of performance characteristics. You can't change the hull lines to get a little more speed and alter them again an hour later to soften the ride in a chop. However, you can get about the same effect by adding adjustable trim tabs.

In case you've never seen a trim-tab installation, it consists of a pair of hinged flaps, similar to those on an airplane wing, mounted on the bottom of the stern parallel with the bottom of the hull. The best are adjustable from the helm and can be reset while under way. Those for

WITH TABS (left) bow-rise at start is minimal. Without tabs at start (center) bow-rise is quite awkward



small fishing boats, however, often have to be adjusted with a wrench while the boat is at rest.

Pushing the tabs down produces a lifting effect at the transom, the amount of lift being determined by how far the tabs are depressed. Each tab can be controlled independently to produce lift on either side of the stern.

Trim tabs have been around for a long time, but strangely enough, they aren't too well understood by many boat owners. For some odd reason, a few people still lump them with stern wedges and shingles (which are permanent additions mounted on the bottom of the boat) and dismiss them as stopgap solutions to bad design errors.

To clear up some of these misconceptions about trim tabs and find out just how well they really work for the average boat owner, *PM* mounted a set of Tempo's hydraulically controlled 18-in. tabs on Executive Editor Jim Liston's 18½-ft. cruiser and ran tests.

In this installation, all the cards were stacked against the tabs. Tempo engineers warned us that tab installations on deep-vee hulls, such as Jim's, were "touchy," and that the tabs would perform more efficiently on shallower vee or flat-bottom hulls.

Also, none of these tests were in the all-out speed end of performance, since we assume people spend more hours at cruising rpm rather than full throttle. Since tabs are dynamic mechanisms, however, they function more efficiently at higher speeds and more dramatic results probably would have been obtained from high-speed runs. We passed these up in favor of tests more closely meeting most boat owners' day-to-day requirements.

ON PLANE (right). It takes 11 seconds without trim tabs, and only 8 seconds with the tabs in operation



HELMSMAN'S VIEW while climbing to plane demonstrates tab's safety advantages. Top photo was taken as boat was squatting; bottom, on reaching plane

Here's a quick recap of the tests and the results we obtained:

Speed at cruising rpm

Test. Load consisted of normal equipment and full fuel tank, plus helmsman and passenger. To simulate the effect of two extra passengers, four 70-lb. concrete blocks were placed in the stern on either side of the engine box. Each test consisted of two two-way runs at 2500 rpm through a surveyed one-mile course. Results were averaged.

Results. Without tabs, the average time





through the course was 3 minutes, 50 seconds. With tabs down, average time dropped 10 seconds to 3 minutes, 40 seconds.

Conclusions. A 5 percent increase in speed was actually quite a sharp improvement in terms of this low-rpm test. However, there were other, more dramatic advantages which couldn't be measured, primarily in handling. For instance, the boat had an 18-gal. fuel tank mounted on the port side which caused the hull to lean and the steering to drag. In the tabs-down tests, the port tab was depressed fully, while the starboard tab was put down only part way. This brought the port side up, making possible hands-off steering. It also showed up in throttle control. With the tabs adjusted as described above, the helmsman could set the needle at 2500 rpm at the beginning of each run and the needle would hang right on the mark for the whole run. Without tabs, however, the boat was hypersensitive to wave conditions. The slightest wake would cause it to slow momentarily and begin to slip off plane, making the engine lug and rpm drop. When the throttle was readjusted to maintain a steady 2500 rpm, the boat would slowly climb back to a full plane, then scoot ahead. Once the load was off, the engine would stop lugging and the tach would show a sharp jump in rpm. All the no-tabs runs were marked by this continual need to readjust the throttle, a condition which completely disappeared when the tabs were used.

Low-speed cruising

Test. With the concrete blocks removed, the boat was run through an 18.2-mile course at a steady 2500 rpm, the owner's normal cruising rate. No tabs were used. Then a second run through the course was made at 2200 rpm, a minimum which would have been impossible without the use of tabs.

Results. The first run took one hour

INSTALLING TRIM TABS is a comparatively uncomplicated operation. Top photo shows the sharp deep-vee angle of our test hull. Tab location was first outlined and holes marked for drilling. The entire area under the mounting plates was then caulked to prevent leaks. Once the tabs themselves were in place, the hydraulic lines were routed through holes drilled above the waterline and up to control station at the helm. Lines were filled via the master cylinder at the control station and connected to tab cylinders

and required 5.3 gallons of fuel which cost \$2.11. The second run, at lower rpm (with tabs down), took 1½ hours, using 5.4 gallons of gas which cost \$2.17.

Conclusions. One unusual fact which came out of this is that tabs make it possible for you to get 50 percent more cruising time at no extra cost and at no sacrifice of comfort or handling. This may seem like a dubious advantage to water-skiers, but it's a big plus to the gunkholer who enjoys just cruising around at minimum rpm, enjoying being on the water. The only negative handling characteristic at lower rpm was a slightly slower recovery from waves and wakes. This was more than balanced by the decrease in engine noise.

Ability to hold a plane

Test. Concrete blocks were loaded aboard again to simulate a four-passenger load. Throttle was set at 2300 rpm.

Results. With tabs depressed, the boat held a full plane indefinitely. When tabs were raised, however, speed dropped sharply within three seconds. The boat slid quickly off plane and commenced to plow.

Conclusions. The ability of trim tabs to lower minimum cruising rpm was even more evident with a simulated full load, especially when the weight was concentrated near the stern as it is in most runabouts and small cruisers.

Climbing to plane

Test. With same simulated four-man load, the throttle was set at 1500 rpm, then jammed full-on to find how long it took to climb to plane. Three runs were made with tabs down, then three without tabs. Results were averaged.

Results. Tabs down, the boat planed in

8 seconds. Without tabs, it took 11 seconds.

Conclusions. This is a clear-cut demonstration of one strong advantage of tabs. It cut 3 seconds off that dangerous time when the boat was running bow-high with the helmsman's view almost completely blocked to nearby dangers.

General conclusions

Quick planing, low-rpm cruising, and to a certain extent, fuel economy seem to be the strongest measurable advantages that we discovered in these tests. However, the ones we couldn't measure—handling, comfort, ability to trim the boat to suit water conditions—may be even more important. Here's what Jim Liston had to say after a season of use:

"I started shopping for trim tabs after an unsatisfactory cruise one day with two heavyweight guests aboard. We had been loafing along and I gave her the throttle to get up on plane. While she labored to get up, I turned and saw my passengers looking frightened when they found themselves sitting 'way down there while I rose high above them. I cut the throttle. With those heavyweights back there, getting up on plane was a slow, sloppy operation all afternoon. Trim tabs have cured that. With fatties in the stern, I use full tab, give her the gun, and I'm up.

"It used to be that when a heavyweight traded places with someone on the port side, for example, I'd either have to ask him to move or run with a bad list. Now I compensate with a little more port tab and she trims out beautifully.

"Biggest advantage, though, is that in a chop I can keep this baby on plane at lower rpm. Instead of punishing the boat and jarring the passengers, I'm planing just fast enough to stay up there, which is where this boat belongs." ★★★

LIST TO PORT caused by fuel tank and passengers on that side affected handling adversely without tabs



PORT TAB DOWN and starboard tab only partially depressed brought hull back up to perfect lateral trim





Lasers go underwater

Lasers are being used in underwater experiments to determine how useful the beam is in detecting ships, submarines and fish. Present laser equipment is expected to be able to penetrate for 1000 feet—five or six times the distance of ordinary light.



Basketball on unicycles

A new basketball league has been formed by the San Diego Unicycle Club—and the gimmick, of course, is that all players are on unicycles. One of the few rule changes for the one-wheelers: A player has only three wheel revolutions before he must dribble.



Airborne cleanup for oil spills

Detergent sprayed from two 11-foot booms suspended under a helicopter can clean up oil spills in the ocean. The spraying device is shown during a demonstration by Mobil Oil off the coast of Louisiana.



Instant replay disc

The highly polished and plated aluminum disc is used to record color television images for instant replay during sports broadcasts and to record documents in information systems. Maker is Ampex Magnetic Disc Dept.

POPULAR MECHANICS



Little Harvey is a pop-up specialist

When an umpire in the Oakland baseball stadium needs a new supply of balls, all he does is give a signal and Little Harvey rises out of the turf, lifting the baseballs on his head. Umpire Al Salerno is shown utilizing Harvey's services, while the fans watch with amusement.



Road signs for flying cops

German police are experimenting with huge arrows along the autobahns to mark control zones so helicopter-borne officers can spot traffic offenders more easily. Motorists talk of retaliating by camouflaging their cars.

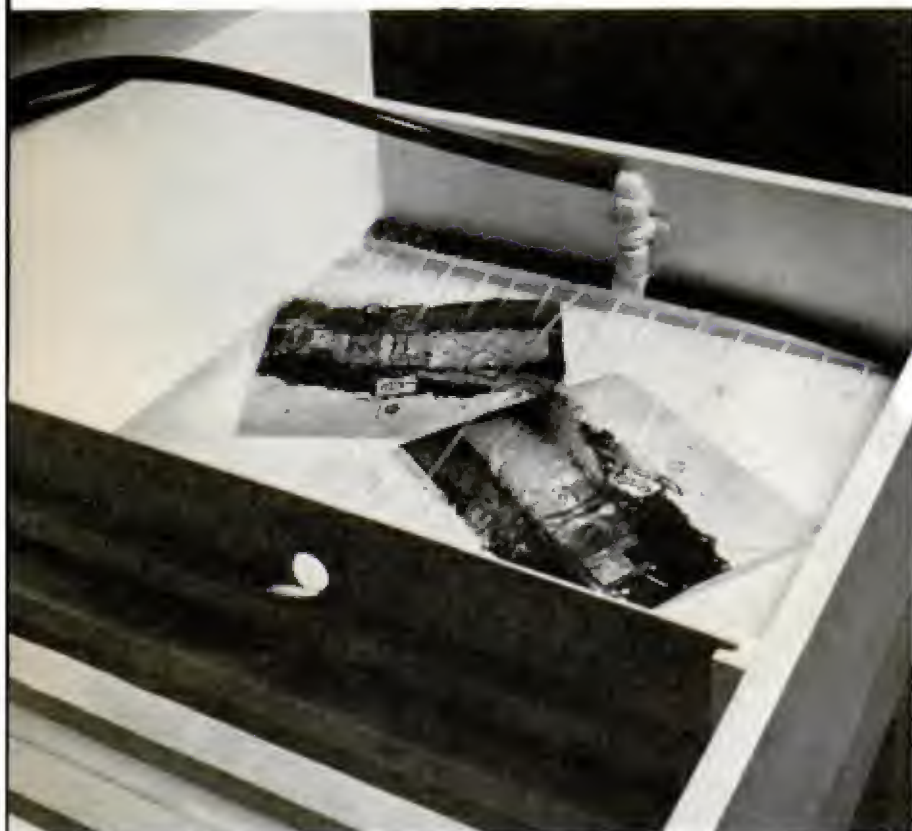


Preflight re-entry test

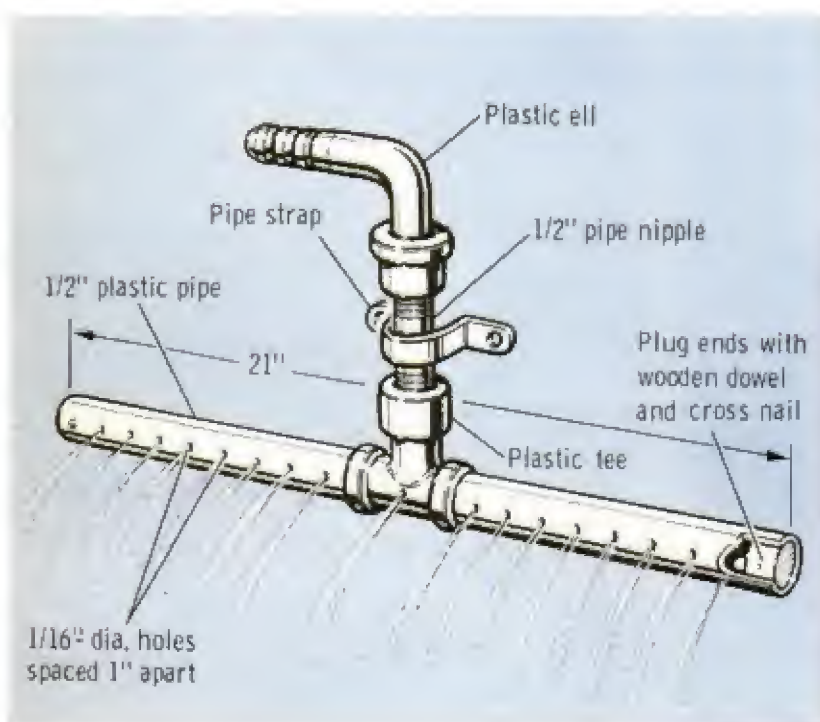
Among the ground tests of Apollo equipment before the astronauts went into space was this decelerator run. Air-propelled sled, stopped by water brakes, showed how Apollo couches would stand landing impact.

ANYONE CAN MAKE Darkroom Sink With a

By R. S. HEDIN



PRINTS ARE WASHED AUTOMATICALLY at one end of sink while processing is going on in trays at other end. Jet spray is made from plastic pipe and stock fittings. Partition holds in water



ANYONE who does his own photo processing usually longs to have a big, professional-type sink and an automatic print washer—items that in commercial form are far too costly for a home darkroom. This homemade wood sink gives you both features in a single unit that's easy to build.

The setup makes for a speedy assembly-line operation. The washer is right next to your processing trays. As prints come out of the trays, you plop them into the wash water without having to move. Jets of water swirl the prints and separate them, thoroughly washing both sides.

You can vary the size of the sink to suit your own needs and space. The dimensions shown here provide plenty of room for the print washer at one end and three good-sized processing trays at the other end. The trays rest on a removable drain rack that makes it easy to keep the sink clean.

The washer section is partitioned off with a slip-in gate of thin hardboard. This forms a dam, keeping water in the washer. Water is fed in through spray jets made by drilling small holes in a length of plastic pipe, as shown at left. An overflow hole in the gate allows dirty water to drain off as fresh water is added, maintaining a constant level.

The gate is held in slotted cleats and can be slipped out to drain the washer quickly after use. While it should fit fairly snugly, it doesn't matter if it leaks a bit around the edges

THIS SIMPLE WOOD-FRAME Built-In Print Washer

Technical Art by Indugraph



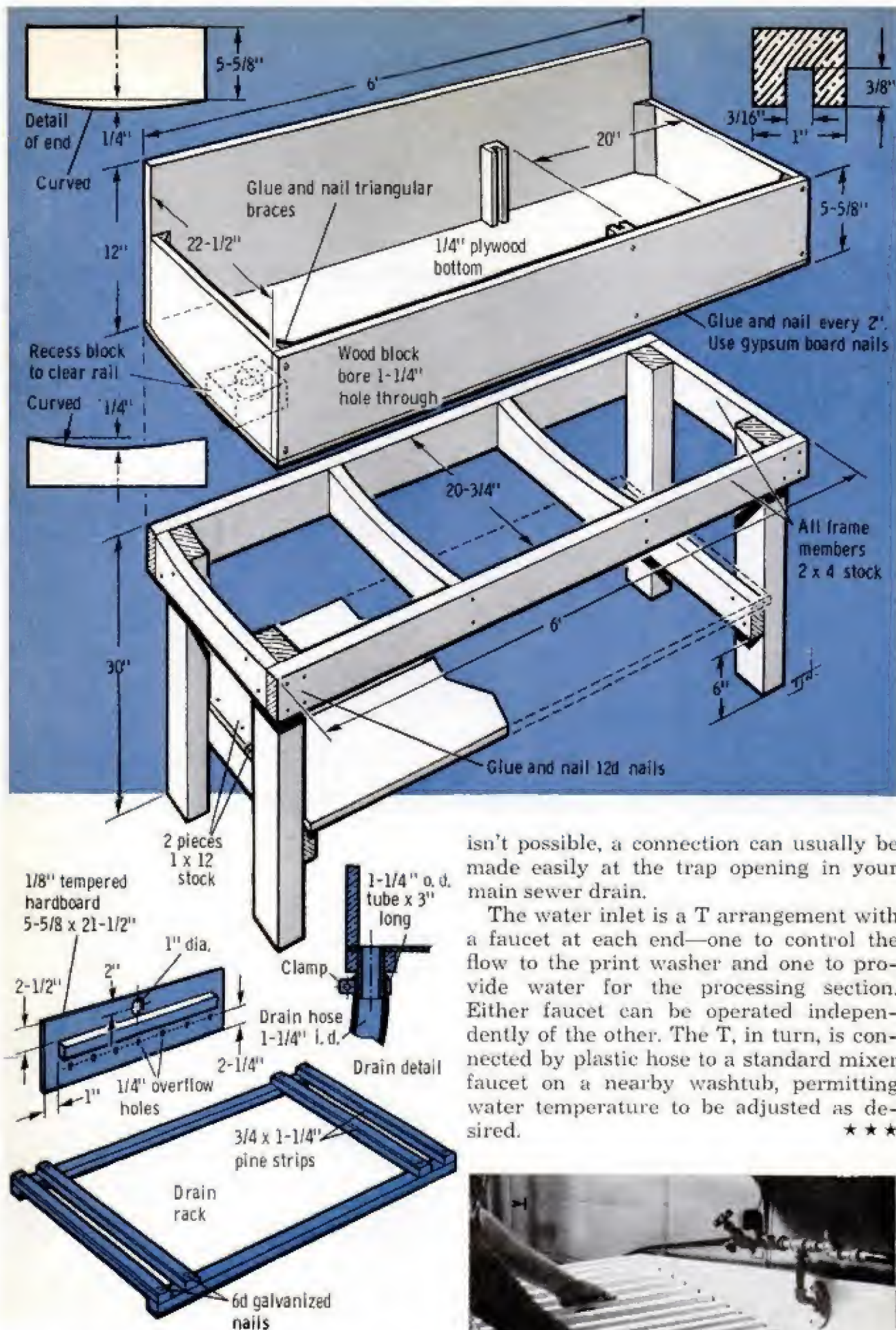
T-SHAPED INLET PIPE has two faucets, one for processing section and one for print washer. Shelf below the sink stores chemicals, as shown at right

since the washer is constantly draining anyway. To make the sink itself watertight, use waterproof glue at all seams and finish the wood with several coats of sealer and enamel.

The sink is made self-draining by dishing the tray end slightly, as shown in the drawing. A hole is drilled through the bottom at the lowermost point and a drain hose is attached. Water flows automatically from the print washer down into the dished end and out the hose. To help the draining action, also shim up the sink slightly at the washer end—about half a bubble on a spirit level.

If your darkroom should be located near a basement floor drain, it's a simple matter to run the sink hose into this, eliminating the need for permanent plumbing. If this





REMOVABLE DRAIN RACK supports processing trays, is lifted out for easy cleaning of sink. Drawing shows how sink bottom is rounded to drain off water

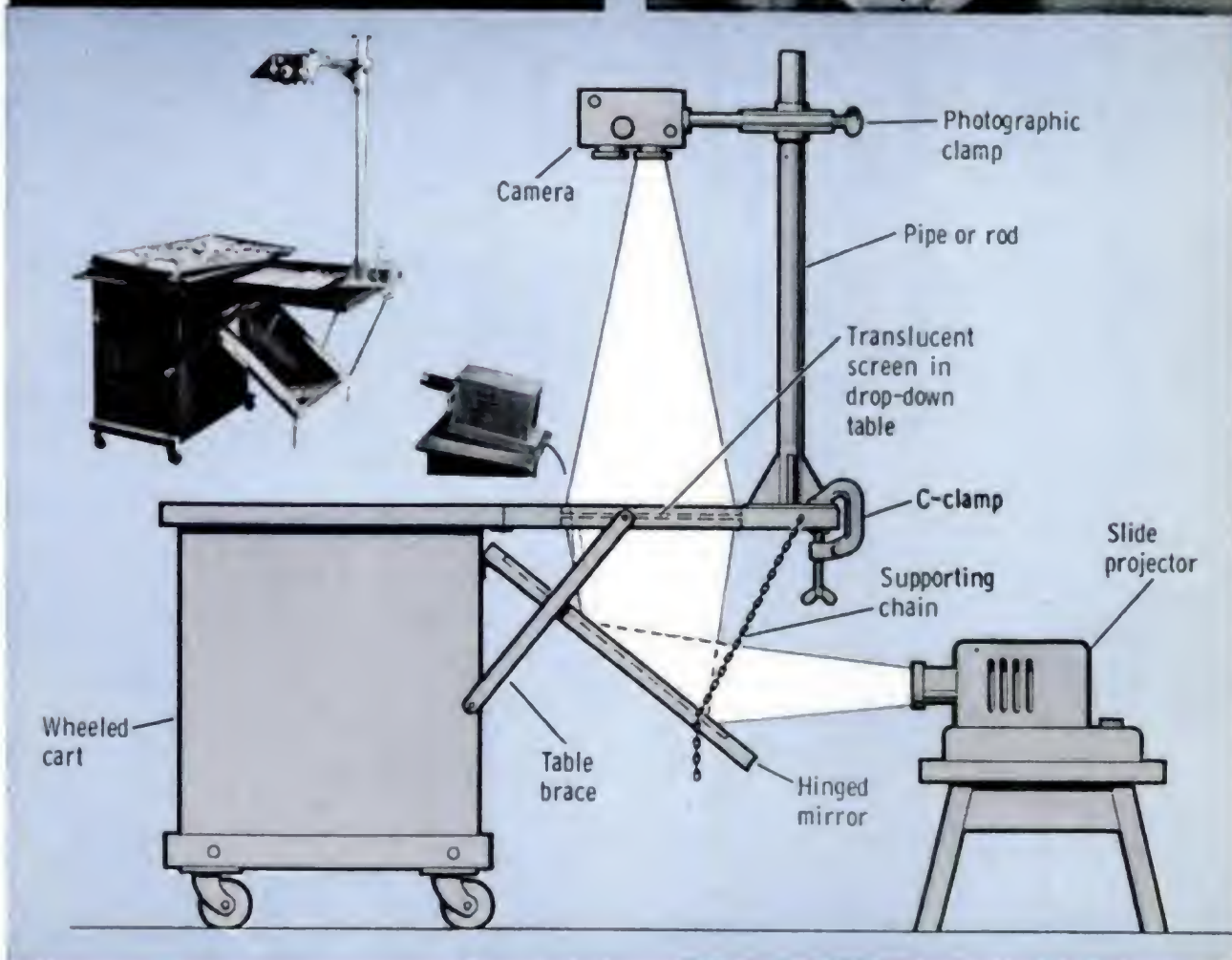
isn't possible, a connection can usually be made easily at the trap opening in your main sewer drain.

The water inlet is a T arrangement with a faucet at each end—one to control the flow to the print washer and one to provide water for the processing section. Either faucet can be operated independently of the other. The T, in turn, is connected by plastic hose to a standard mixer faucet on a nearby washtub, permitting water temperature to be adjusted as desired.

★ ★ ★



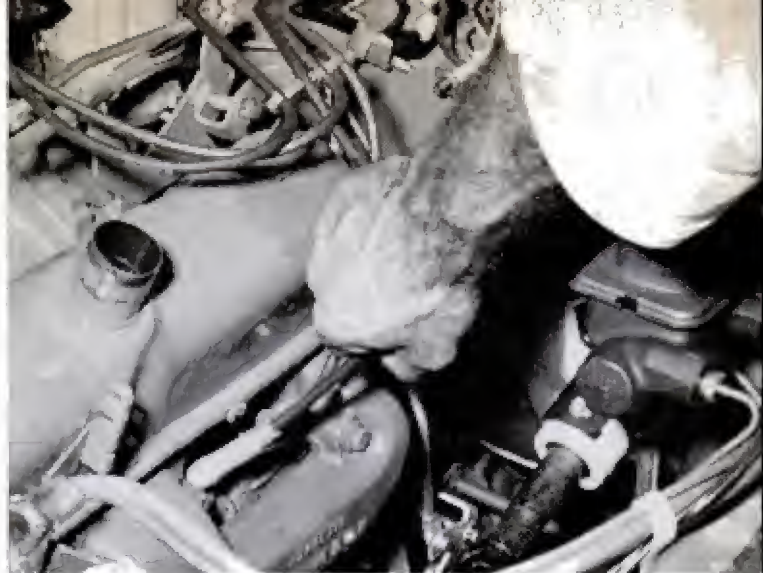
PHOTO HINTS



DRAMATIC TITLES FOR SLIDE SHOWS are easy to produce with this setup. You project one of your prize slides onto a translucent screen, arrange titling letters on top of the screen, then photograph both together. The result is an ingenious, Hollywood-like effect in which your title appears magically superimposed right on the picture. You'll need a piece of opal glass or white translucent plastic about 18 inches square for the screen. Below this, arrange a mirror at a 45° angle so the image from your slide projector can be directed upward onto the underside of the

screen. Movie titling letters, available in many sizes and styles at photo stores, are then laid out on the screen, as shown at upper right. Turn on the projector and measure the light at the screen with an exposure meter. Using color film with an ASA rating of 125, typical exposures are 1/50th of a second at f/8 or 1/10th of a second at f/22. With slower ASA 25 film, exposures run to 1/5 of a second at f/5.6 or half a second at f/8. To be safe, bracket a stop or two on each side. I used a small wheeled cart to mount a hinged mirror and screen, as shown.—*Frank E. Hewens*

Your ignition cables may look good, but beneath the insulation they could be damaged. Here's how to check and replace them before your engine starts to misfire



MANHANDLING can damage conductor inside ignition cable. Don't copy bad example; handle by boot

How to Replace Your

By **MORT SCHULTZ**



IGNITION SYSTEM secondary circuit uses TV and radio suppression (TVRS) cable to carry high voltage. At times called "resistance" cable, it suppresses the electrical pulses of the ignition system to minimize interference with surrounding radio and TV reception and reception on your car radio. Cable connects each sparkplug to distributor cap and the coil to center tower of the cap. One tipoff that cable may be damaged and need replacement is a misfiring engine



SPARKPLUG CABLE RESISTANCE, checked with ohmmeter, should meet specs, usually about 20,000 ohms



SPARK INTENSITY gives idea of cable condition. Damage results in too-high resistance, weak spark

Car's Ignition Wiring

YOU MAY HAVE WONDERED why it should ever be necessary to replace ignition wiring. If the insulation is still good and the wiring is not visibly damaged, what can be wrong with it? The answer is that ignition wiring is not conventional copper wire. It's "electronic suppression cable" often referred to as "TVRS" for television and radio suppression cable, and it can be damaged internally.

These cables, as their name indicates, reduce electrical pulses emitted by your ignition system which interfere with surrounding radio and TV reception and also with reception on your car radio.

The construction of TVRS cable is unique and has been the subject of some controversy. Actually the controversy over suppression-type secondary ignition cables has been going on for almost 20 years. Only the other day, for instance, a man wrote *Auto Clinic* that his mechanic told him, "The only reason car manufacturers use TVRS cable is to reduce costs." This man's letter is typical and points up some serious misconceptions about TVRS cable. In fact, some mechanics are going so far as to recommend that TVRS cables be replaced with the older type copper conducting cable which does not use a graphite-shrouded conducting center to provide the resistance needed for electronic suppression. This is not necessary

and I think it's time we explored the truth about the vices and virtues of TVRS cable.

As you know, the secondary cables in your car are those which connect the distributor cap to the sparkplugs, and the one that connects the center terminal of the distributor cap to the center terminal of the ignition coil. Pontiac was the first to use electronic suppression cables in 1950. Since then, every major manufacturer in the country has made the cables original equipment on new cars.

It's true that many car owners have been experiencing trouble with these cables. Most times, the conductor strands separate, causing excessive resistance and insufficient current at the sparkplugs. The result is engine misfire. However, in most cases this trouble is a direct result of shoddy handling of cables by mechanics, including many Saturday Mechanics.

What is *not* true, though, is the contention by the mechanic quoted above that TVRS cables cost less money than copper conducting cables. Actually, electronic suppression wiring costs about 50 percent more than copper cables. The additional expense results from the way in which TVRS cables are made.

The center conductor is composed of strands of linen or glass fibers around which is usually woven nylon thread. This assembly is immersed in a liquid graphite

solution which is then coated with liquid neoprene.

At this point, the assembly is tested to make sure that resistance is uniform over the entire cable. A resistance of no more than 1000 ohms per inch is typical.

Finally, the assembly is covered with rubber insulation, around which is placed an outer jacket of neoprene to protect the rubber insulation from oil and grease.

Interference is a problem created by the automotive ignition system every time a spark occurs at a sparkplug. The very-high-frequency oscillations in the secondary circuit when a plug discharges cause electromagnetic waves to radiate.

When resistor-type ignition cables are introduced into the ignition system, however, this interference is reduced by reducing the peak current that flows as the sparkplug discharges. Without resistance, this peak current may reach 200 to 500 milliamperes. With resistance, it is reduced to between 1 and 10 milliamperes.

Generally, automotive ignition systems can tolerate up to 20,000 ohms of resistance without any undesirable effects. However, the exact resistance limit of each cable depends upon the cable's length. For example, with the 1968 Plymouth, the allowable resistance is as much as 30,000 ohms. You'll need to know just how much resistance your car maker allows for cables, so check the service manual.

In testing cables to assure they have not exceeded resistance limits, the most accurate way is with an ohmmeter. The best place to get one is in an electronic supply

TO REMOVE CABLE from sparkplug, grasp the boot firmly, give a slight twist and pull off straight



store. One that will do this job will cost you about \$10.

Remove the cable from the car, lay it on a bench and probe the cable terminals with the meter leads. The meter's reading shouldn't exceed the allowable resistance limit for the cable. If it does, the cable is damaged and should be replaced.

Don't forget to test the coil-to-distributor cap high-tension cable, too. The resistance of this cable is usually less than that of sparkplug cables. For example, as mentioned, sparkplug cables of the 1968 Plymouth are rated at no more than 30,000 ohms. The resistance of the coil-to-distributor cap high-tension lead of this car should not exceed 15,000 ohms.

If an ohmmeter isn't available, a less accurate way to find out how a cable is functioning is by the spark intensity test.

Disconnect the sparkplug cable from the plug and insert a terminal adapter in the terminal. Hold the adapter about 1/4 inch from a good ground, such as the exhaust manifold, and crank the engine. A good spark should jump the gap at regular intervals.

If the spark intensity of all wires is satisfactory, the coil, condenser, rotor, distributor cap and secondary wiring are okay. If the spark is equal at all wires, but weak and intermittent, the fault lies with the coil, distributor cap, or coil-to-distributor high-tension lead. If there is a weak or intermittent spark with some wires only, those cables are probably damaged and should be replaced.

Some Saturday mechanics will contend that when they replaced TVRS cables with copper wiring and resistor sparkplugs, their engines stopped misfiring. Sure they did, but let's look at the likely reason.

Most people in changing cables also replace or clean sparkplugs and distributor breaker points. It's quite likely that in making these other changes, they removed the *real* cause for a misfiring engine. Even the simple action of removing a cable ending from a sparkplug which has a dirty terminal can eliminate a cause of misfire. The terminal could be wiped clean by movement of the cable ending.

Certainly, changing to copper wiring and using resistor plugs will provide electronic suppression, but this is the expensive way of doing things. Not only do you have to pay for new cables, but those plugs cost about \$1.50 each. That's \$12 for

plugs alone. By comparison, replacing every cable in an eight-cylinder engine with TVRS cable costs only \$8.50.

I wouldn't recommend that you operate your car without some means of ignition system suppression. Forget the other guy's TV and radio. Your car's radio will be affected. So will your sparkplugs. Without some resistance in that ignition system, there's an increase in amperage across the sparkplug gap which can quickly erode the electrodes and ruin your plugs.

Cables are handled frequently—every time sparkplugs are cleaned or replaced, and whenever the ignition is timed.

If not handled correctly, a cable's thin, fragile conductor can be pulled apart. Once broken, resistance within that cable increases and engine misfiring can result.

So, never grab the cable at its center and jerk it from a plug, and never flex the cable back and forth or twist it. Don't puncture the cable with a probe either. This causes separations in the conductor. The correct way to remove sparkplug cables is to grasp the rubber boot or molded cup and twist it slightly to break its seal. Then, lift the boot (and cable) straight up with a steady, even pull.

If you really want to be safe, you can use special pliers (about \$2.50 at an automotive supply store) that allow you to remove and handle TVRS cable with little danger of damaging it.

Here are other facts about TVRS cable:

- Electronic suppression cable is sold either in packaged prefabricated sets ready for installation or in reeled bulks

SPARKPLUG CABLE PLIERS, used by pros, give good leverage for removing cables without damaging them

of 100 feet. I recommend the prefabricated sets, because they come with terminals and boots and in the right lengths. Cost is about \$8.50.

A reel of wire, on the other hand, will cost you about \$14. You must measure each cable to the exact size of the old cable and cut it from the bulk. Boots and terminals must be attached, which calls for crimping terminals to the cable. You have to buy boots and terminals separately. Boots cost about 15 cents each—terminals about 10 cents each.

Electronic suppression cables, by the way, can be identified by labeling on the cable, such as "electronic suppression" or "Radio-GM TVRS."

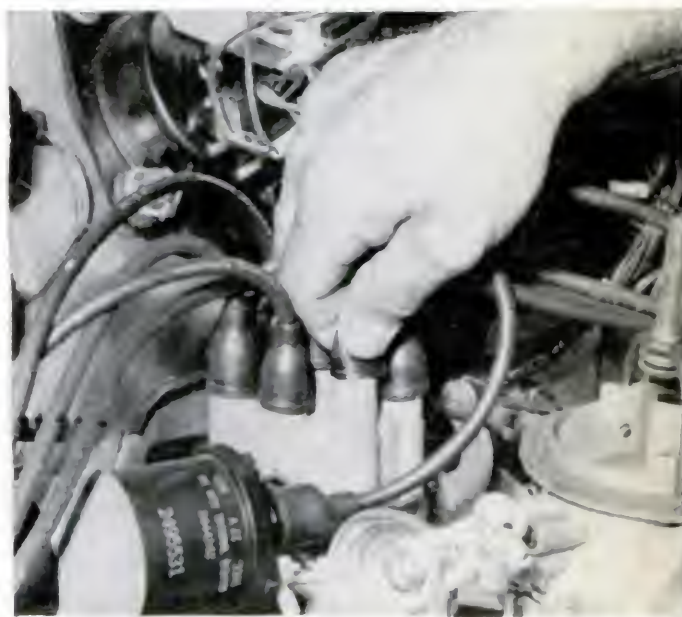
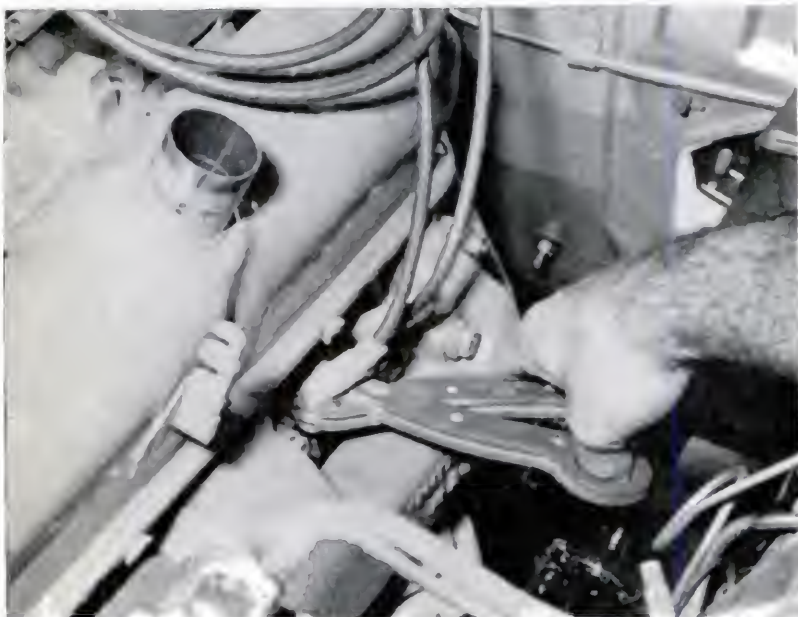
- Any cable that is frayed, corroded at the terminals, or has cracked insulation should be replaced. Wipe cables with a kerosene-dampened cloth to check them.

- Although cables might be in good condition, they should never be allowed to operate with defective sparkplug boots. If boots are cracked, replace them. They allow carbon tracks to form on a sparkplug insulator and cause the plug to short.

- There's a knack to seating cables in the distributor cap towers. Improper seating causes a gap that allows corrosion to form. This can lead to misfire.

Install the cable and boot assembly over the tower, entering the terminal into the tower. Push lightly. Then, pinch the large diameter of the boot to release air which may be trapped between the boot and tower. Continue pushing and pinching the boot until the cable is seated. ★ ★ ★

ON DISTRIBUTOR CAP, fully seat cables by pushing down while squeezing boot to release trapped air



8 WAYS TO HOP UP

Modifying your two-cycle motor, like the racers

By HANK and VERA BRADSHAW

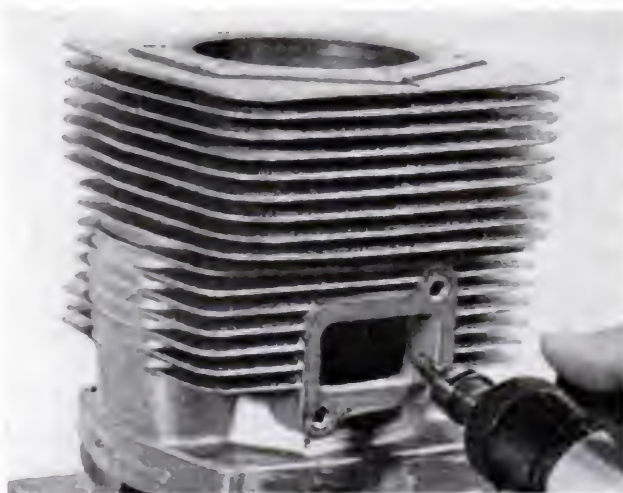
RIGHT NOW, you can probably do 40 to 50 mph with your snowmobile. But by hopping up its engine you can add 4½ hp, 500 rpm and get about 65 mph out of your machine.

Methods shown here were actually used by experts, including Dave Bode at Polaris Manufacturing Co. in Rouseau, Minn.

We took a German-made, 372-cc JLO two-cycle engine designed for 20 hp at 5000 rpm. The modifications shown can be done on most any two-cycle reciprocating snowmobile engine.

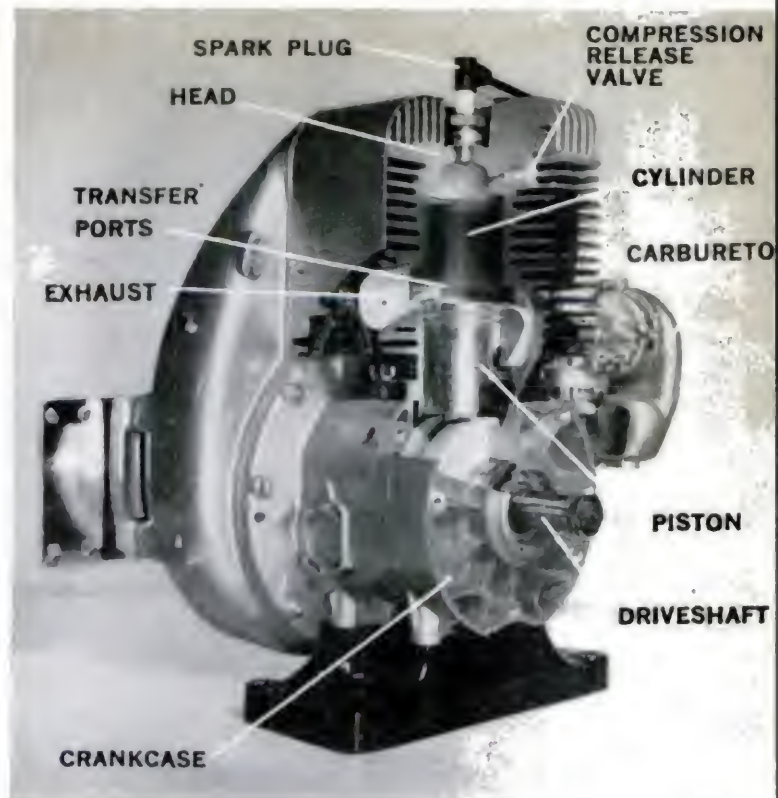
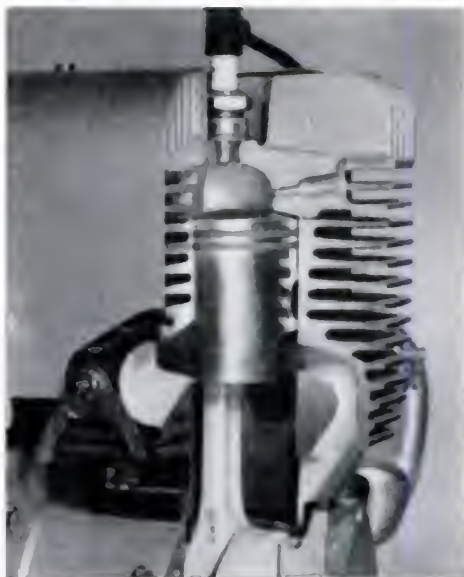
Engine modifications include the polishing and altering of the intake and exhaust ports; milling the head; boring the cylinder to oversize; skirting the piston, and golf-balling the piston. You may also want to increase the size of the carburetor from the normal 1⅜ in. to 1½ in. Specialty companies make an adapter block so you can mount the large carb.

Changes in exhaust system will produce the most noticeable power increases, but engine changes must be made first or the new exhaust system will not affect power.



POLISHING PORTS. With a drill-file, carefully polish the bottom of the carburetor intake port and the top of the exhaust port. This cat's-whisker alteration lets more fuel vapor into engine and allows better exhausting of the cylinder. These ports are cast and rough to the touch. You want to polish them smooth—that's all. Be sure not to remove too much. Adjust the timing for engine efficiency after altering ports.

CUTAWAY OF SNOWMOBILE ENGINE shows various parts involved in a modification. Photo at right shows piston at the bottom of cycle. The transfer ports are visible behind the piston. Photo below shows piston up. Carburetor intake port can be seen beneath piston



A SNOWMOBILE ENGINE

do, will add power and speed to your snowmobile



MILLING THE HEAD. With the chuck of a lathe screwed into the sparkplug hole in the head, take off about .10 inch. This is generally the depth of the lip found on many heads. Removing the lip will decrease the cylinder and dome space, thus increasing the compression for more power. Make sure that the piston does not hit the head. If it does strike the head, make a fly cut by trimming back the edge of the dome slightly.

JANUARY 1969



BORING CYLINDER TO OVERSIZE. Increasing the cylinder size lets in more fuel, giving more power. You can bore out the cylinder on a home lathe or have it done in a machine shop. Most mechanics cut from .080 to .100 inch. This leaves room for reboring should a broken ring scar the cylinder wall. Removing .100-inch will increase the capacity from 372 to 396 cc on this JLO. A larger piston will be needed for the cylinder.

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SKIRTING THE PISTON. Skirting is done to let more fuel vapor enter the crankcase before the downward-traveling piston seals off the carburetor intake port. Remove the piston from the cylinder. File off $\frac{1}{8}$ to $\frac{1}{4}$ inch from the bottom of the piston. This is done only on the side of the piston which covers the carburetor intake port. The exhaust side remains the same.

After skirting the piston, you can lightly file the piston head at the edge of the top where it passes the transfer ports. This will allow the full crankcase charge to pass to the cylinder.

With provision for increased fuel, it's a good idea to file about $\frac{1}{8}$ inch off the edge of the piston top where it passes the exhaust port.

GOLF-BALLING THE PISTON. Added fuel in the cylinder means more heat. More heat means more lubrication. Thus the need to golf-ball the piston. With a dull drill bit, pockmark the piston surface. These indentations should be about $\frac{1}{16}$ inch deep. Oil will be retained longer, lubricating the piston walls.

EXHAUST SYSTEM. With all the foregoing modifications, plus the addition of an $1\frac{1}{2}$ -inch carburetor, you're ready for exhaust-system changes. Changing the exhaust will really snap up your horsepower. You have three choices:

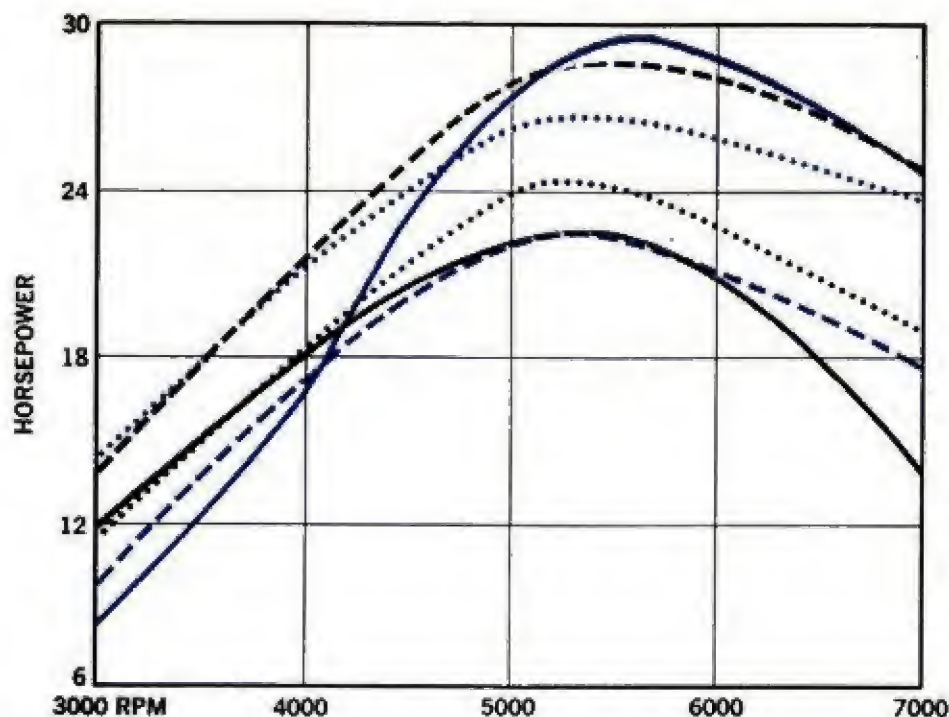
1. Install a straight pipe to exhaust the engine fumes downward. The straight pipe is the best dissipator of heat. Unless the heat is dissipated rapidly, the engine might seize or blow up. Normal operating temperature of a cylinder under the sparkplug when using a straight pipe is about 350°F .

2. Install a megaphone exhaust, eliminating the gases out the side of the hood instead of down. This creates more noise but gives a broader power range, although there might be some heat problems. The normal temperature when using a megaphone is about 550°F . For a 372-cc engine, megaphones should have a 12-inch bell of approximately $3\frac{1}{2}$ inches diameter at the mouth.

3. Install an expansion chamber. Only an expert knows when this can be used successfully. It can cause burn-out problems in the engine. Assuming that everything is correct, however, expansion chamber exhausts will give an engine more power in a narrower and normally higher rpm range.

"If we knew why," said the experts, "we'd be millionaires." All the experts know is that the answer lies in back pressure and resonant waves returning to the cylinder. However, your engine may run about 700° —that's just 35° below the point at which an engine will blow up.





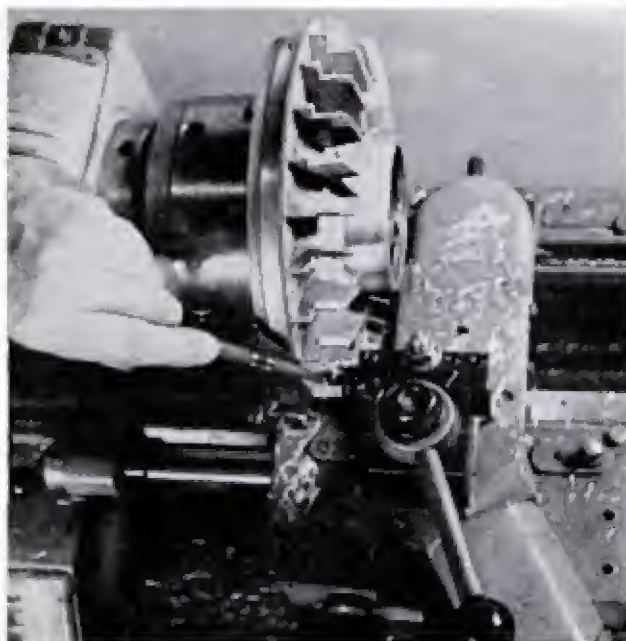
MILLING THE FLYWHEEL. This modification cuts the total weight of a snowmobile. With snowmobiles generally operated in cold weather, the extra weight of cooling fins on the engine is not needed. Clipping the fins in a lathe and milling down the flywheel itself from $\frac{1}{2}$ to 1 inch (depending on thickness) will cut from 4 to 10 pounds of weight. Less weight, more speed.

If you don't need the cooling fins, then you don't need the engine housing. Removing this cover will knock off another 8 to 10 pounds from the total weight of the machine.

With all these modifications you have added from $4\frac{1}{2}$ to 5 hp to your machine. It should be a greater racer now.

EXTRA SPROCKETS. These are valuable for extra speed. Whether you'll use the small, medium or large gear depends on snow conditions, terrain and length. A small gear gives quick starting, is good for rough-country races where you're speeding up and slowing down. A large gear gives you slow start, but top speed. Normally, racers change the top sprocket. Another modification is changing your present clutch to a variable-speed-drive clutch. This increases torque at low rpm and speed at high rpm.

Modifying your snowmobile can be fun. But remember, it voids any warranties, and cuts down on engine life. Nevertheless, you can add snap and zing to your machine. ★★★



Unique Idea in Link Roller Chain



DOING THE TWIST. Double-pitch chain (above) shows how much it can flex in following a tortuous path around out-of-line sprockets. Photo at bottom of page shows how chain with a single cable is joined with a flat link connector



FLANGED PLASTIC ROLLERS clinched between flexible stranded cables form a single-pitch concept



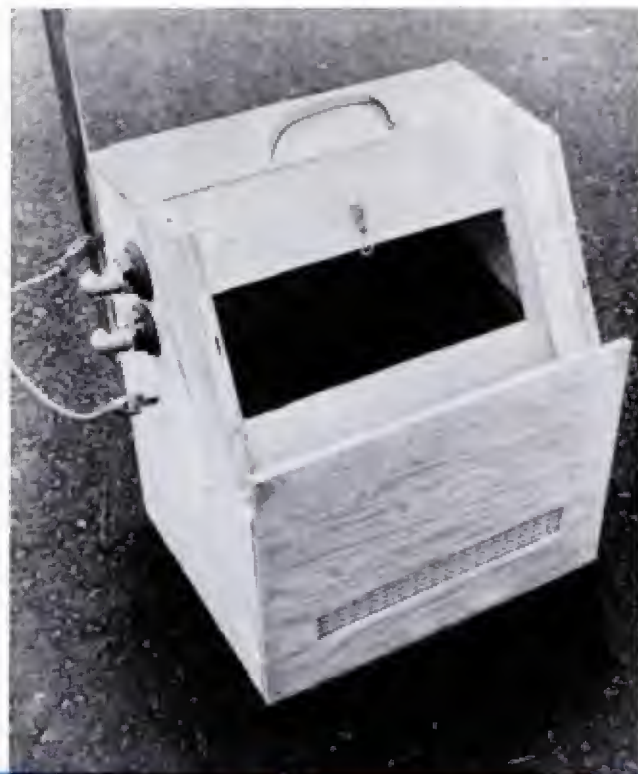
THERE HAVE BEEN better mousetraps and better can openers, but in the last 50 years there has not been a better link roller chain—not until now. During these five-decades there has been little or no significant change in the conventional bicycle roller chain.

Now, however, Winfred M. Berg of East Rockaway, N. Y., has come up with something really different in a cable-and-roller drive system which could make the common link roller chain as obsolete as the horse and buggy. He calls it Pow-R-Tow.

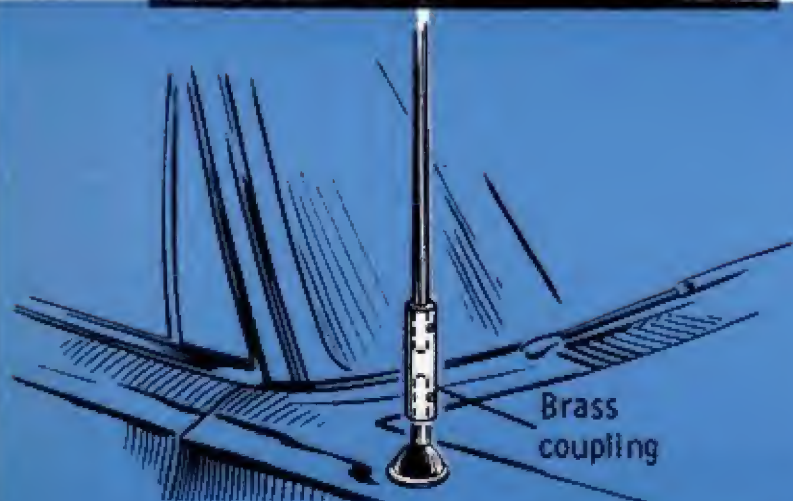
What's better about this new chain? Several things. Molded from a tough fiber-glass-filled plastic, it requires no lubrication. It's lightweight (25 percent lighter than conventional roller chain). With no metal-to-metal contact between chain and sprocket, it's smooth and quiet-running. It can be cut with wire cutters and spliced in a jiffy. Two design concepts will handle double and single sprocket drives. ★★★

ELECTRONIC KINKS

SMALL PORTABLE RADIOS have two faults—they sound tinny because of their small speakers and their reception is weak in fringe areas. This bass reflex baffle can help to cure both. It improves sound quality by boosting the bass and it incorporates an external antenna for better reception. The baffle is just a plywood box with a sloping front and a small ledge to hold the radio at an angle.



Bass notes from the back of the radio bounce around inside the box and come out a port in front greatly increased in volume. Adjust the box's dimensions to suit your own radio. The inside volume should be about one cubic foot. Make the port slot about 2 in. deep. Lining the back, bottom and one side of the box with acoustical tile or other absorbent material will greatly improve the effect.—K. R. Johnson



A CAR RADIO ANTENNA is often a target for pranksters when you park in a strange neighborhood. To keep mine from being broken or stolen, I hacksawed it off near the base, then reattached it with a small coupling made of brass pipe. Two setscrews in tapped holes hold the sections firmly together. Now when I park I just loosen the coupling and lock the antenna top safely in the trunk.—Wilfred Beaver

POWER CORDS on tools and appliances that are longer than you want can be shortened with a shower-curtain clip. Wind the excess into a coil and snap the clip around it. The clip looks neat and is easier to put on and take off than a rubber band



AN EMPTY PILL BOTTLE can make a handy dispenser for solder. Drill a small hole in the plastic cap near one edge. Wind the solder onto a length of wood dowel that's slightly smaller than the inside diameter of the bottle. Slip the coil into the bottle and thread the end out through the hole in the cap. The solder will pull neatly out as you need it without the usual kinking and tangling



No-Hands Amplifier For Your Telephone



You can pipe two-way conversations to room speakers for the whole family to hear or feed them to a tape recorder for automatic message-taking. Construction is easy because you start with a prewired amplifier

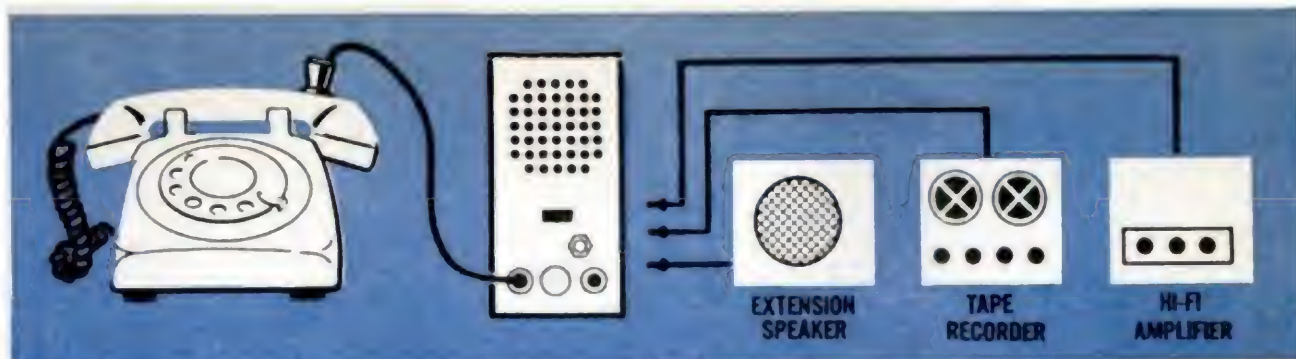
By WALTER SALM

THERE'S SOMETHING positively luxurious about being able to pick up your telephone and hear the caller's voice boom out over a separate loudspeaker without your having to hold the receiver to your ear. It's a joy when you have a message to take down. You just put down the phone and write as the caller talks. Your wife will find it handy for copying down recipes from friends. When someone calls home from far away, it's great fun for the whole family to gather around and listen in together instead of having to take turns with the phone.

The little amplifier shown here will let you do all of these things and more. For

direct listening, it has its own miniature built-in speaker. For bigger sound, you can plug in an extension speaker or pipe the amplifier's output right into your regular hi-fi system. When someone calls, his voice will come almost magically out of your big room speakers. While the amplifier is not designed to serve as a microphone, it's possible to carry on two-way conversations without touching the telephone because the transmitter will pick up your voice from several feet away.

The amplifier also makes it possible to record telephone calls on tape. This is not easy to do with the little transistor recorders that are popular today because



WITH MIDGET AMPLIFIER, telephone conversations can be fed easily to any type of home sound equipment

they don't have enough amplification in the early stages to handle unamplified signals directly from a phone. Also, there's a problem of improper impedance match. The typical telephone pickup coil—the kind you stick on with a rubber suction cup—operates at a high impedance, 15,000 to 50,000 ohms. The average transistor recorder has an input impedance of only a few hundred ohms or at most a thousand or so. The resulting mismatch makes for poor recordings.

The amplifier cures this by incorporating an impedance-matching transformer. It also serves as a preamplifier, giving the telephone signals a boost. The result is good, crisp, full-volume sound. When someone isn't home, you can record a message for him without having to remember it or write it down. If someone gives you complicated driving directions on the phone, you can record them on tape, then play them back right in the car.

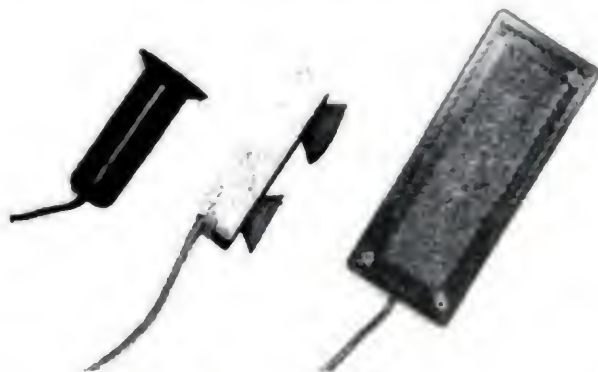
The amplifier is a cinch to build because you start with a prewired unit—a miniature five-transistor push-pull amplifier available from Lafayette for less than \$6. Besides saving work, it costs less than

what you'd pay for the individual parts. It's so tiny it fits perfectly into a $1\frac{5}{8} \times 2\frac{5}{8} \times 5\frac{1}{8}$ -in. Bakelite box. Except for the battery, all of the other parts mount directly on the box's aluminum cover plate.

The prewired unit comes with various sets of leads already attached, making the hookup simple. The leads are color-coded and carefully identified on a sheet supplied with the amplifier. One pair goes to a tiny 2-in., 8-ohm speaker. A second pair goes to a 9-v. radio battery, the kind used in transistor portables. A third pair goes to a double-pole slide switch, and a fourth goes to the telephone input jack through the matching transformer.

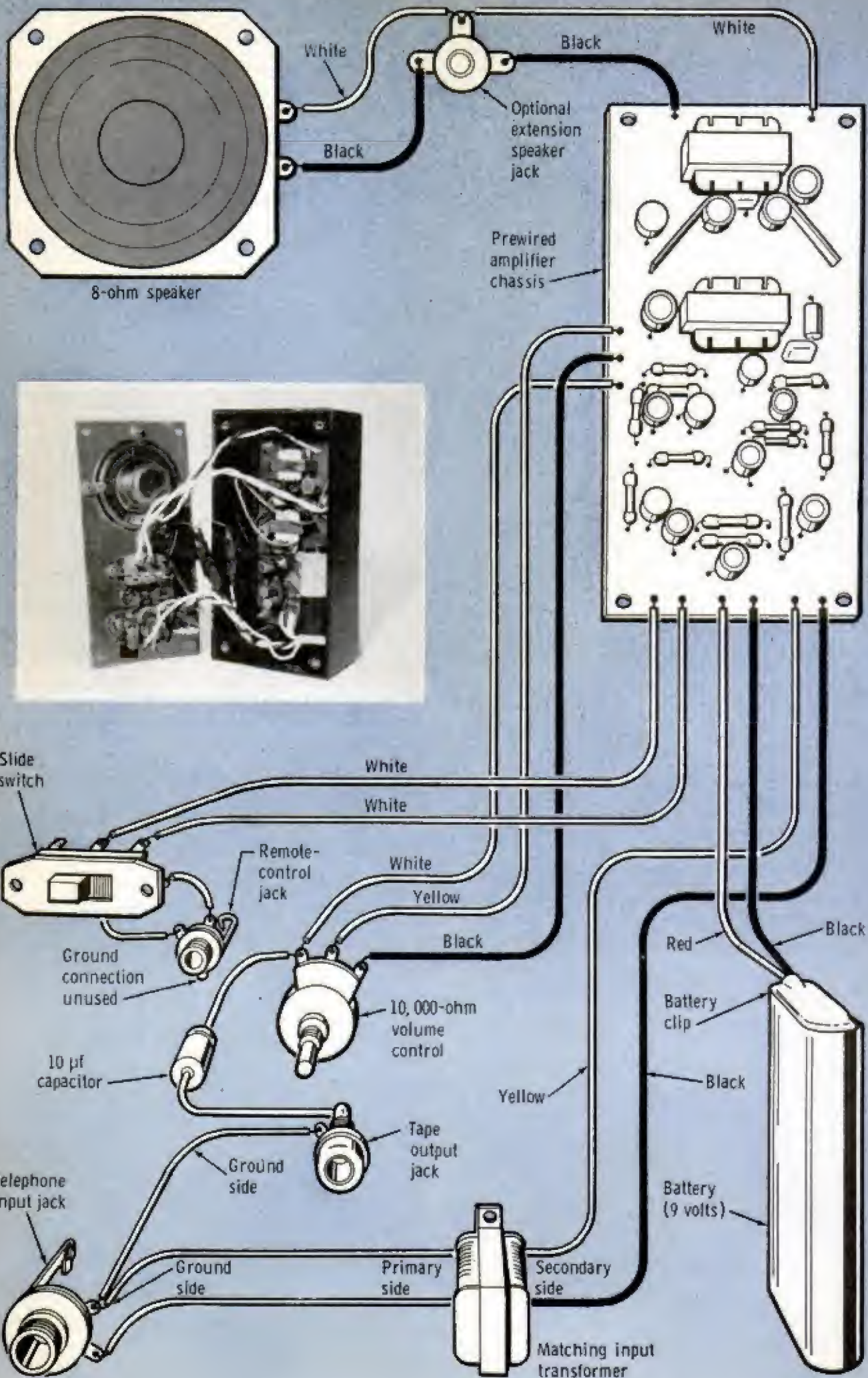
A final group of three leads goes to a 10,000-ohm audio taper volume control. To make the volume control fit inside the box, remove the rear section containing the on-off switch and cut off the excess shaft length. On-off switching is handled by the slide switch instead. The reason for adding this switch is that it gives you an extra set of contacts. These are wired

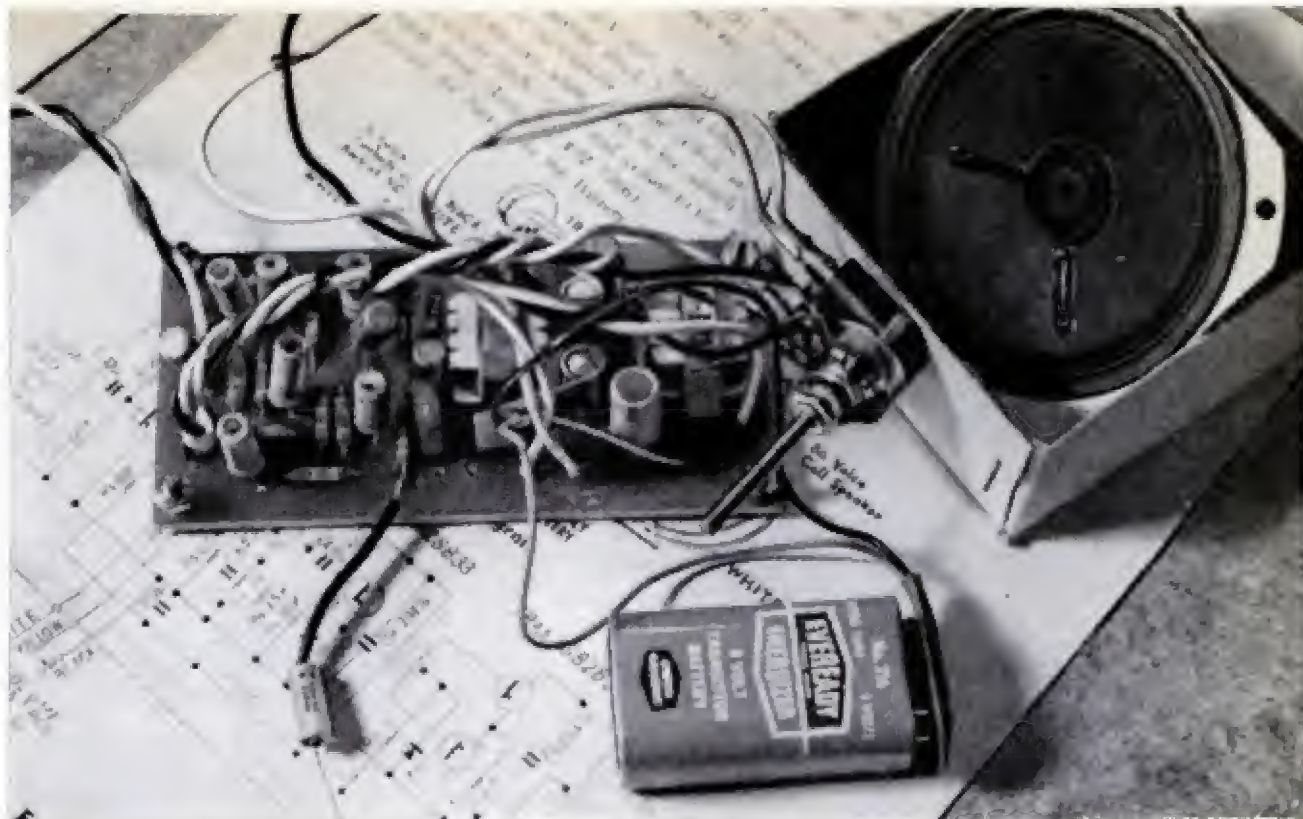
TELEPHONE PICKUPS work by induction, permitting you to hear calls without actually hooking into a phone's wiring. They come in several types. Two at left below are held by suction cups to phone's receiver. Thin, flat kind at right slips underneath the phone's base, can be left in place permanently



TAPING CALLS requires only two connections—one from phone pickup to amplifier and one from amplifier to recorder. Remember that taping is legal only if caller is notified and gives his permission







CONSTRUCTION IS MADE EASY by using this tiny preassembled audio amplifier from Lafayette. It has five transistors, costs under \$6. Speaker shown here is for testing. Actual unit uses a smaller 2-in. type

to a remote-control jack so that the jack is hot when the switch is closed. Many tape recorders have a connection for a remote-control switch to turn the machine on and off from a distance. If you run a cable from this connection to the remote-control jack on the amplifier, your recorder will go on automatically when you throw the slide switch to turn on the amplifier.

Depending on the type of connections you want to make, you may wish to use different jacks from those here. If your telephone pickup has a miniature plug on it, you can substitute a matching miniature jack for the phone jack shown. The tape output jack is a phono type. With a standard phono patch cord, you can feed the telephone signal into your hi-fi amplifier's auxiliary input jack.

To feed the signal into a transistor tape recorder of the cassette type, you will need an adapter cord with a phono plug on one end and a miniature plug on the other. Note that a capacitor is connected between the tape output jack and one of the terminals on the volume control. It's important that the *negative* side of this capacitor go to the tape jack and the *positive* side to the volume control.

The easiest way to provide a grille for the speaker is to drill a circular pattern

of small holes in the cover plate. The jack for an extension speaker is optional. If you add one, use the closed-circuit type and wire it as shown in the diagram. This way, the small built-in speaker is automatically cut off when the larger external one is plugged in.

The following parts list is based on components available from Lafayette Radio Electronics Corp., 111 Jericho Turnpike, Syosset, L. I., N.Y. 11791. Similar parts are also available from other electronics-supply houses. ★ ★ ★

PARTS LIST

- Prewired amplifier**—5-transistor, push-pull audio type (99T9037).
- Volume control**—10,000-ohm audio taper (32T7364); miniature knob (32T2401).
- Speaker**—2-in., 8-ohm (99T6036).
- Transformer**—input matching (99T6034).
- Switch**—double-pole slide (34T3911).
- Capacitor**—10-uf, 15-v. miniature electrolytic (99T6045).
- Battery**—9-v. radio type (99T6021).
- Housing**—1 $\frac{5}{8}$ x 2 $\frac{5}{8}$ x 5 $\frac{1}{8}$ " Bakelite box (99T8075).
- Phone input jack**—telephone type (99T6213).
- Tape output jack**—phono type (99T6234).
- Remote-control jack**—miniature 3-conductor plug and jack set (99T6328).

NEW IN



A CLEVER ARRANGEMENT OF SPEAKERS enables this new Ampex tape recorder to deliver good stereo reproduction without sacrificing a compact cabinet design. Two cube-shaped extension speakers store in the back. For monaural listening, they play through a grille cloth on the front of the cabinet—just like a built-in speaker. For stereo listening, you remove the cubes and place them up to 20 feet apart for proper separation. The recorder threads and reverses automatically, permitting the takeup reel to be hidden out of sight. Model 1461 is \$429. Ampex Corp., 205 W. Touhy Ave., Park Ridge, Ill.

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NEW LOOK IN TELEPHONES: The sleek, palm-size phone above contains transmitter, receiver and dial all in a single hinged unit. When not in use, it folds up, becoming an attractive ornament. Opening it automatically disconnects the bell and connects the voice circuit for making or receiving a call. The maker is Italtel s.p.a. in Milan, Italy. Equally compact is the pushbutton model below. Designed by Western Electric, it uses a tiny printed circuit, may eventually find its way into U.S. homes.



POPULAR MECHANICS

ELECTRONICS



AIM THESE BINOCULARS at another person similarly equipped and you can not only see each other—you can talk back and forth, too. The binoculars send out invisible infrared pulses representing coded voice sounds. At the other end, the pulses are converted electronically back into the original sounds. Two-way conversations can be carried on over half a mile. Battery-run binoculars were designed for military use by Signals Research and Development Establishment in England.



A PIGGYBACK CLOCK perches on top of this novel bedside radio. The two parts, while styled to look like separate units, are actually interconnected. The AM/FM radio comes on at a preset time in the morning to wake you, and a slumber switch turns it off after you've gone to sleep at night. There's also a separate buzzer alarm. Price is \$42.95. Arvin Industries, 1531 13th St., Columbus, Ind.



SWIVEL-MOUNTED COLOR TV above rotates 360° for viewing from any angle. Speakers in the base radiate sound in all directions regardless of which way the screen is turned. Pushbutton controls are hidden under a slide-out panel on top. \$1065, by Andrea Radio, 2701 Bridge Plaza N., Long Island City, N.Y.

BUILD THIS Connecticut

By FRANK L. GREENWALD

A fine example of Colonial design, its simple lines will blend well with either Contemporary or Early American furnishings

AS A PROJECT, this clock has just about everything to recommend it to the home craftsman. The styling is authentic, construction is simple and the cost is surprisingly low.

The clock I built, shown on the opposite page, is fitted with an eight-day short-pendulum movement and a roman-numeral dial. If you would prefer to eliminate the ticking and also the necessity of having to wind the clock once a week, a battery-powered electric movement could be substituted.

The original Connecticut shelf clocks (or "mirror clocks," as they were sometimes called) were made with a variety of different door panels. Some had a small mirror, while others used hand-painted scenes. When they were fitted with pendulum movements, however, a small oval area was always left clear so the pendulum action could be seen.

I wanted the effect of a hand-painted scene, but I'm not much of an artist. Thus, my "painting" is a piece of wall paper cut from a sample roll at the local paint store. I simply glued this to the back of a clear glass panel.



CLOCK MOVEMENT is a standard eight-day short-pendulum type which has a roman-numeral dial.



CUT BOTH RABBETS in one 30-in. board. Then cut the sides and top to length from this board.



RABBET MITER used to join sides and top is begun by making $\frac{1}{16}$ -inch cut $\frac{1}{4}$ inch from the end.



SECOND CUT more than halfway to end is then made and area between cuts is cleaned with saw.



MITER CUT at 45° should just reach the root of the first cut. Sides are then cut to length.



SIDES AND TOP are glued together after miter cuts have been made. Bottom piece is installed later.

Shelf Clock

Technical Art by INDUGRAPH



Shelf Clock (Continued)

I used common white pine since it is considered authentic for this type of clock, but many early New England clocks had cases of cherry, mahogany and walnut.

The sides and top of the case require a piece of wood $\frac{3}{4}$ -in. thick, 4 in. wide and approximately 30 in. long. I ran the front and rear rabbets along the sides of the piece before cutting it up into specific lengths. I even found it best to first sand it, using No. 80 grit paper and then No. 220.

The sides are joined to the top piece by a joint called a rabbet-miter which you'll find makes a strong joint and simplifies the job of clamping. To cut such a joint you first set the blade on your table saw

$\frac{3}{16}$ in. high. Then you set the fence so it's $\frac{3}{4}$ in. from the outside of the blade. Make the cut across the end of both side pieces first, then shift the fence so you can make a second cut halfway from the end of the pieces. The area between the cuts is cleaned out with two or three passes. Now set the fence $\frac{7}{16}$ in. from the outside of the blade and make a cut across both ends of the top piece. With this done, set the blade at 45° and miter each end. The miter cut should just reach the root of the first cut. Finally, make similar miter cuts at the upper ends of the side pieces. You can now trim the side pieces to $9\frac{3}{4}$ in.

The next step is to glue the miter joints and clamp them. A temporary spreader piece across the bottom of the assembly



GLUE AND NAIL the mitered joints with 6d finishing nails. I blunted the nail points to avoid splitting



BRAD POINTS keep base pieces from shifting when gluing. Drive them part way, then cut off heads



TIGHTEN CLAMPS slowly and evenly so as not to force mitered corners out of line; apply as shown



BACK OF CASE fits flush in rabbets previously cut in top and sides. Back laps bottom of case



AFTER GLUING butt corners of door frame, $\frac{1}{8}$ -in. splines are inserted, glued and trimmed flush



HINGE MORTISES are cut in frame only. Make approximately $\frac{1}{8}$ -in. deep to assure proper clearance



MOVEMENT IS MOUNTED on dial backing plate, then used to determine location of support cleats



MAGNETIC CATCH, stripped of its frame, is fastened to case with screw through center hole



STRIP OF PAPER is used to check minimum clearance between minute-hand shaft and glass of door

will assure square corners. It's best to use just a scrap at the bottom now so that any variation in width at the top caused by clamping can be compensated for by cutting the final bottom piece. Fasten the latter with glue and 6d finishing nails.

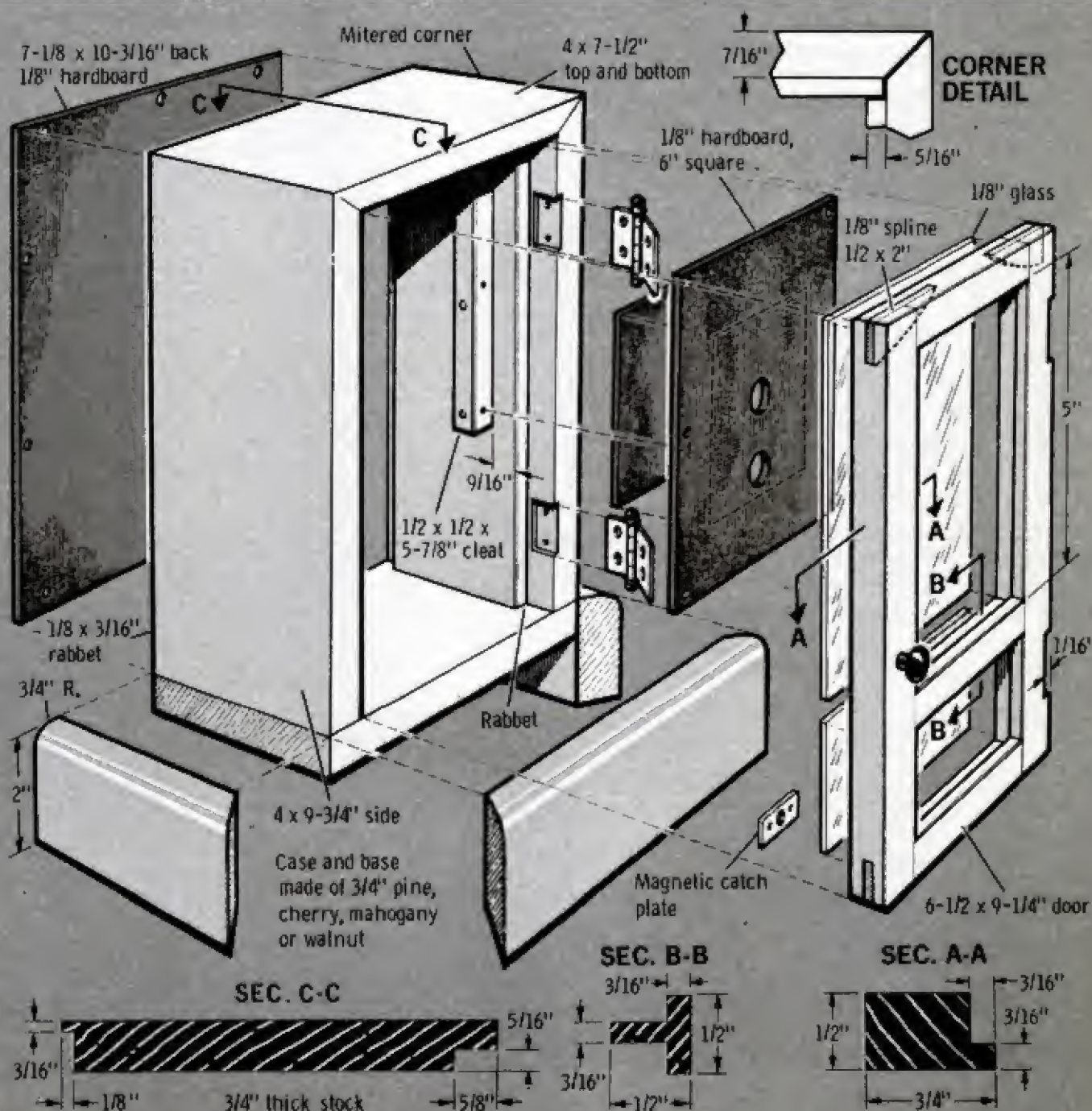
Next, rip a 20-in.-long piece for the three base pieces. I used my molding head to round the top edge, but you can also form it with a hand plane and sandpaper. The strip is cut into three pieces and mitered to fit around three sides of the case at the bottom. In doing so, the important thing to remember is that the inner face of the front piece must extend the full width of the clock case. The side pieces of the base were left extra long for final trimming after the miters are checked for

a good fit. I drove small brads into the case at the bottom and cut the heads off so they'd impale the base and prevent shifting when gluing and clamping it.

Screwing the hardboard back to the case completes the job. Use 1/2-in. No. 6 oval or flathead screws to fasten it in the rabbets.

Simple butt joints are used to make the door. I rabbeted the members for the two pieces of glass and then glued the door together. After the glue dried, I ran saw kerfs in the joints at the corners and inserted splines. Fit the door to the case so there is 1/32-in. clearance at top and bottom and 1/16-in. at the sides. The hinges are mortised into the edge of the door

(Please turn to page 221)



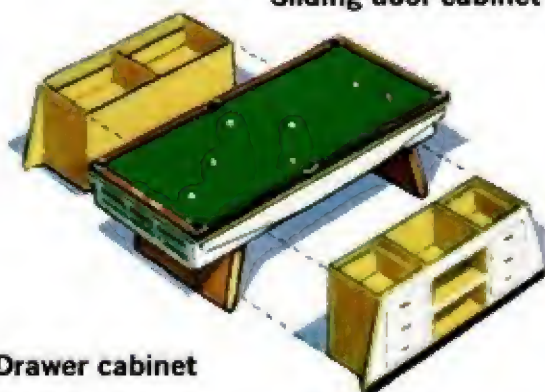
Build This Storage Into Your Pool Table

Color Photo by Robert Borst

WISH YOU HAD more room to store the dozens of games and other gear that clutters your playroom? Stop wishing! There's space aplenty going to waste right under your nose—more specifically, right under your pool table. All you have to do to put it to work is tuck a couple of roomy cabinets between its legs and you'll wind up with storage galore that's as handy as can be.

If you happen to have a Brunswick table such as the Monarch shown at the right, you can follow the cabinet dimensions given. Because of a central connecting stretchers which joins the legs of the table shown, it was necessary to build two separate cabinets. With other makes of tables you may find that a single cabinet can be built and slid in place. In each case, overall dimensions will

Sliding-door cabinet



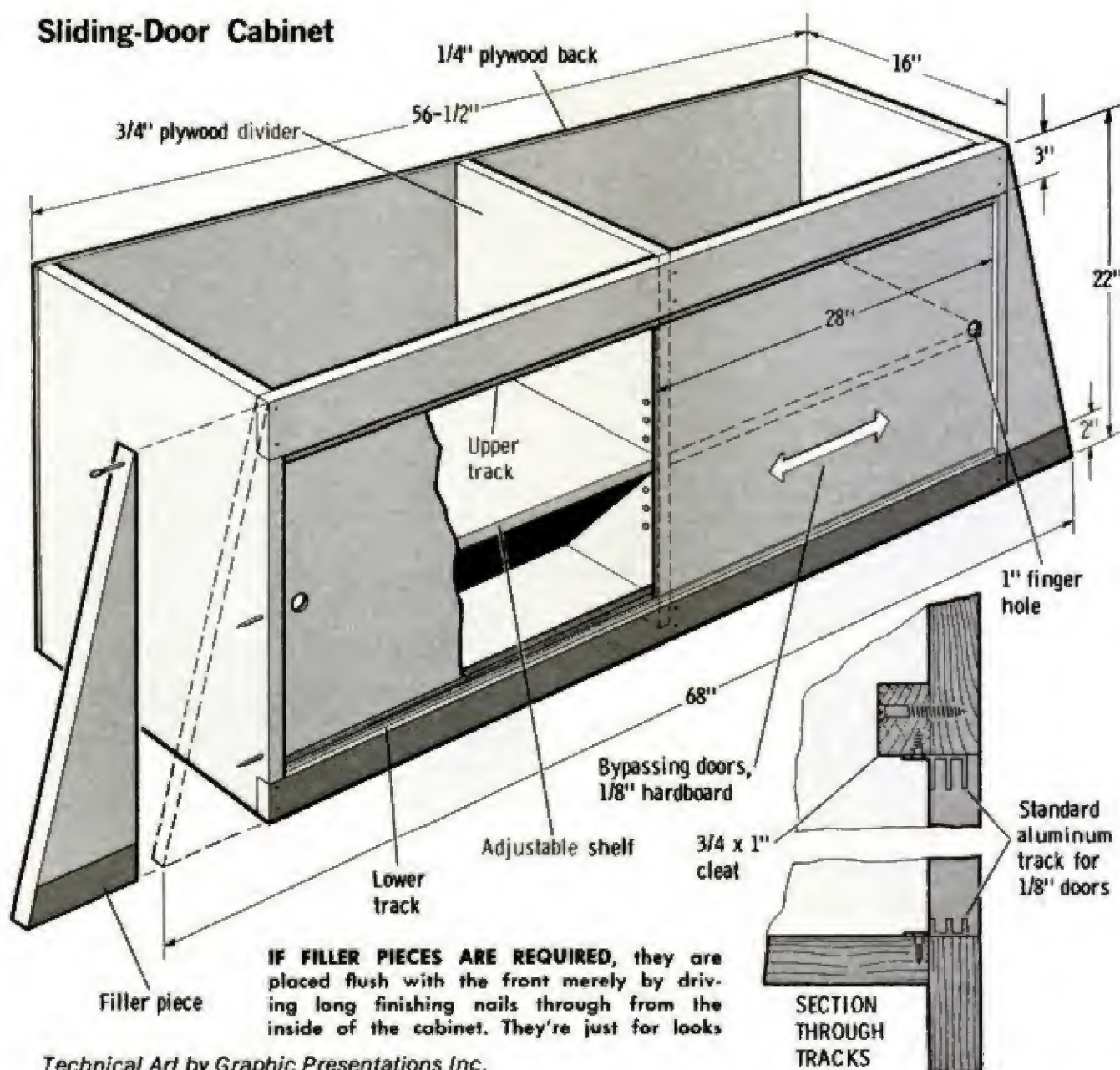
Drawer cabinet





Simple plywood cabinets nest between legs of pool table to convert waste space into handy storage

Sliding-Door Cabinet



Technical Art by Graphic Presentations Inc.

vary with the particular table you own.

You have a choice of building twin cabinets, or one with sliding doors and the other with drawers. Both types are detailed on these pages. The main difference in the sliding-door cabinet detailed above is its center divider. While only one is required, you will notice it is not notched at the front for the crossrails.

In making both cabinets, cut and notch all the ends and dividers exactly alike, cutting them from 3/4-in. fir plywood. You can rip the crossrails from plywood or solid stock. Glue and nail the crossrails in the notches, then place the assembly face down on the floor and nail on the 1/4-in. plywood back. The bottom for each compartment of the door cabinet is cut to fit and tapped in place, even with the top edge of the lower crossrail. When it's level, you nail it in place through the front,

sides and back with finishing nails. Nails driven through the divider at an angle will anchor the two bottom members to it.

The shelves are loose-fitting and made adjustable for height by boring rows of holes for regular 1/4-in. shelf rests.

Standard DIY aluminum track is used for the 1/8-in. hardboard doors. Notice in the section view that the deeper of the two tracks is mounted across the top. Thus, you can insert the doors in the tracks after the latter are screwed in place. Because the tracks are set in 1/8-in. or so from the edge, cleats are required across the tops of the door openings to provide a screwing surface for the track.

As is the case with both cabinets, tapered filler pieces are required to fill the space between the cabinet ends and the slanting table legs. The particular table will determine whether these pieces are

Drawer Cabinet

16"

22"

1/4 x 3/4" runners

56-1/2"

1/4" plywood back

24"

3"

9"

14-3/4"

68"

2"

Three equal-size drawers

Except for back, entire cabinet is made of 3/4" plywood

Drawer sides 1/2" plywood

Drawer front 3/4" plywood

Drawer bottom 1/4" plywood

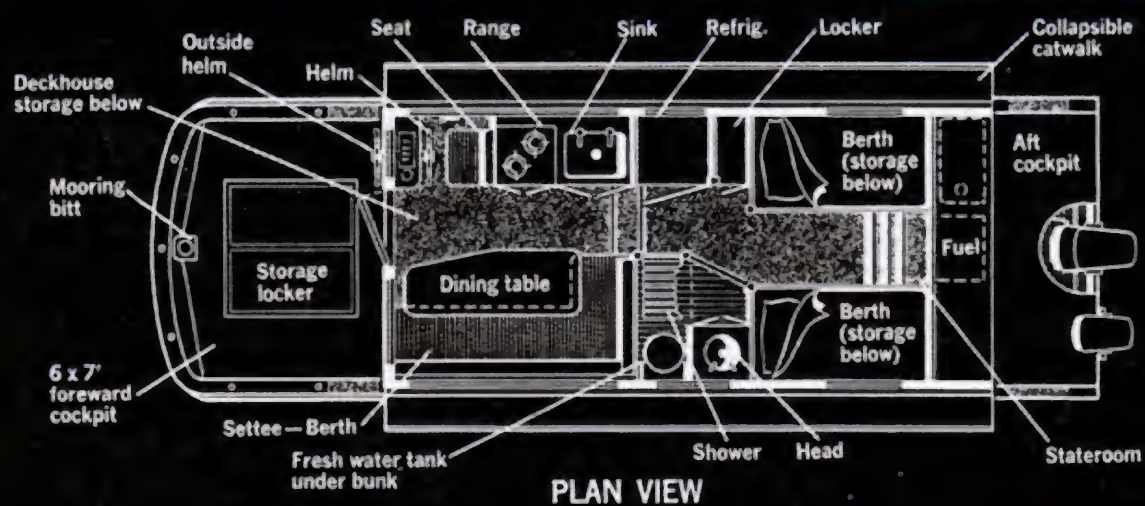
1/4 x 3/4" groove for drawer slide

Filler piece 3/4" plywood painted black across bottom

All six drawers have identical flush fronts and dadoed sides. You can mass-produce the drawer parts quickly with table-saw setups which will guarantee duplicate pieces. After all fronts are cut, run the rabbets at the ends and a $\frac{1}{8}$ -in. groove $\frac{1}{2}$ -in. up from the bottom on the inside face. Similar grooves are made on the inside faces of the drawer sides for hardboard bottoms, then the work is turned over and a drawer-guide dado is run down the middle. Drawer backs are cut to fit between the sides and rest on the drawer bottoms. Allow suitable clearance on all sides so that the drawer

Add the 1/4-in. runners to the sides of the dividers and end pieces. These are spaced and located by trial, after light tacking in position with small brads and then checking the sliding fit of the drawer. When it pushes in easily, without binding, nail the runners permanently. Coat d-a-does and runners with paste wax for a nice sliding fit. Handles complete the job.

To place the cabinets between the pool-table legs, you must first lift off the top of the table. Then with both cabinets standing back to back you lift the leg-and-stretcher assembly up over the cabinets and nest the stretcher between them. The top can now be replaced. The filler pieces actually fit inside the slanting, tapered legs of the table. You can screw the cabinets to the stretcher if you wish, although it's not necessary. ★ ★ ★



Build This Houseboat For Under \$1000

You can put together this floating home and trailer it to any place there's water

By **DAN FALES**, Boating Editor

Photos by *Ralph Poole*

I COULDN'T BELIEVE my eyes when I first spotted the houseboat. "This isn't homemade," I told myself. "It must be manufactured." But I was wrong. The boat was built at home by Byrl Graham. It took 10 months working weekends, a buddy, and less than \$1000 to construct the bare boat.

Byrl finished it a year ago, and since then he's used it almost every weekend. He takes family and friends up and down the Lake Mohave section of the Colorado River—a 67-mile stretch.

He pokes into isolated coves; trolls for large bass and trout; camps at water's edge in some of the most beautiful country in the United States. He enjoys his boat.

Designed and tested by Glen L., this houseboat has one big advantage over others—it's trailerable. You can load this 8-ft.-beam boat on a trailer and take it

anywhere you find a launching ramp.

"Anyone can build it," Byrl says. It's true that he has modified the plan some. He's changed the position of the hanging locker; put the shower outside in the stern; added steps and storage space; changed the head somewhat. But it's basically the same boat that you can build from plans.

In the past, a build-it-yourself houseboat was designed to look like a barge—with blunt bow and scowish-looking lines. But today, a houseboat is a sleek craft that parts the water with a vee bow. Graham's type of boat is no exception. It has a shaped bow. However, shaping the bow might present a construction problem.

"We molded two 3/8-in. layers of plywood planking over frame and stem," Byrl says. "I think it would be easier if others used a laminate of three layers of 1/4-in. plywood instead of two layers of 3/8-in.,

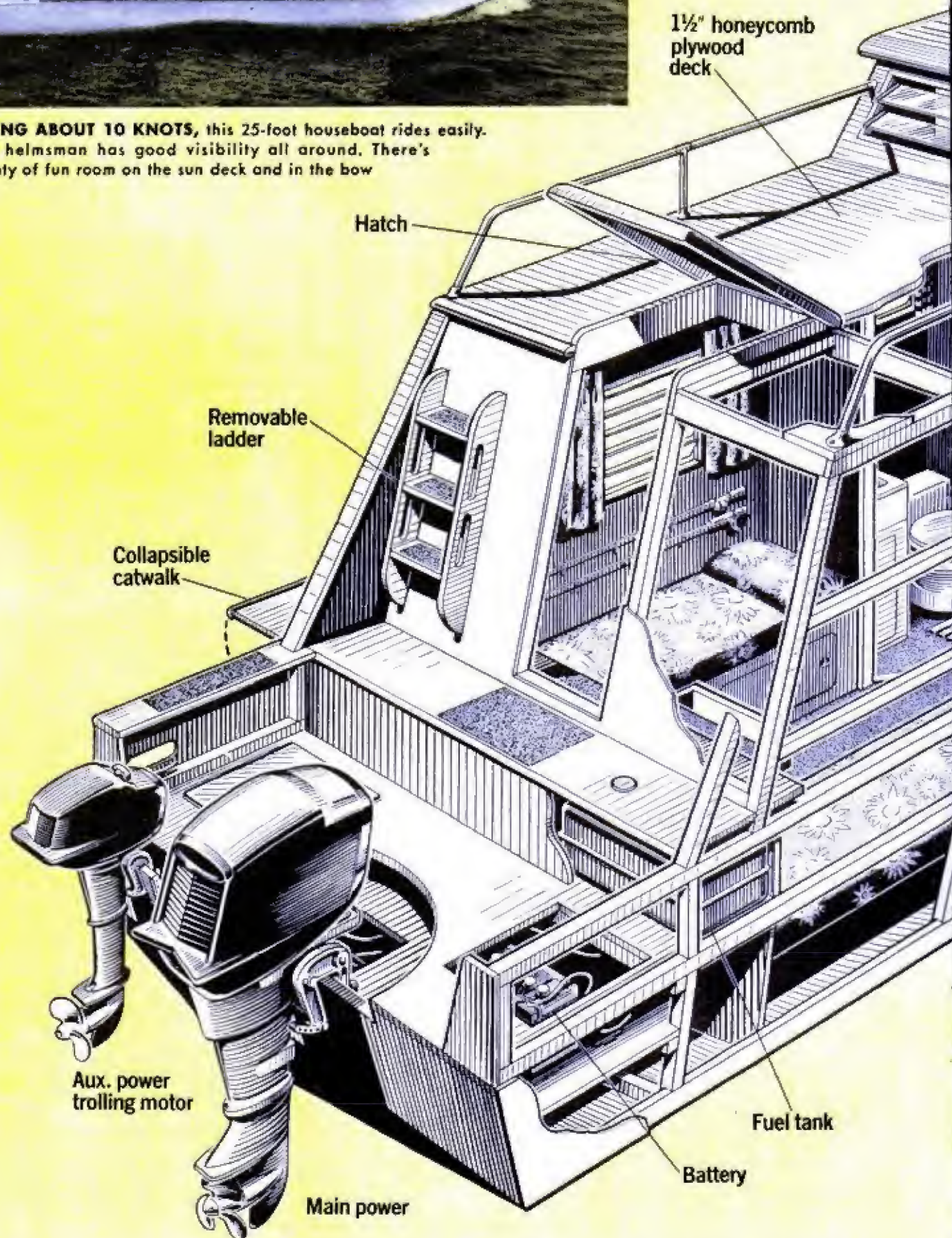
BYRL GRAHAM (center), author (right) and Howard Honaker relax aboard 25-ft. houseboat after lunch

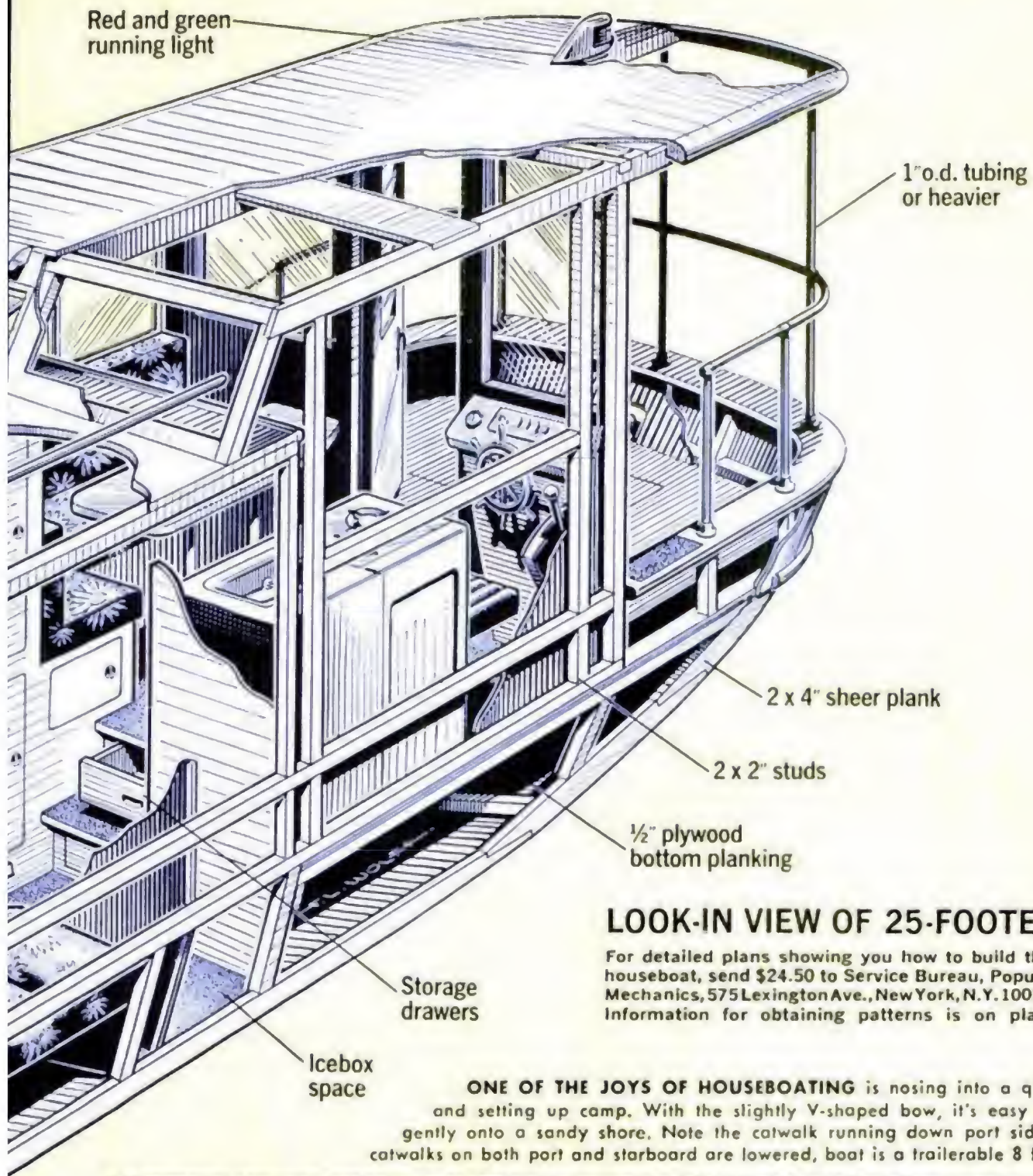
CATWALKS ON EACH SIDE are approximately 18 in. wide, making it easy for a person to "get around"





DOING ABOUT 10 KNOTS, this 25-foot houseboat rides easily. The helmsman has good visibility all around. There's plenty of fun room on the sun deck and in the bow





LOOK-IN VIEW OF 25-FOOTER

For detailed plans showing you how to build this houseboat, send \$24.50 to Service Bureau, Popular Mechanics, 575 Lexington Ave., New York, N.Y. 10022. Information for obtaining patterns is on plans

ONE OF THE JOYS OF HOUSEBOATING is nosing into a quiet cove and setting up camp. With the slightly V-shaped bow, it's easy to bump gently onto a sandy shore. Note the catwalk running down port side. When catwalks on both port and starboard are lowered, boat is a trailerable 8 feet wide





VIEW THROUGH DECKHOUSE: past compact galley, into the main cabin and out through the stern door

since the $\frac{3}{8}$ s are hard to bend and hold in place while gluing. I tried everything from hot towels to wetting the plywood on the lawn with a garden hose. I finally managed, but thinner stuff would surely be easier to work."

This was the only operation in which Byrl found the construction to be difficult. The rest of the project was rather easy, he says.

The finished houseboat looked as if it

CATWALKS CAN BE DROPPED when entering a tight mooring slip or preparing the boat for trailering



BUNKS FOR TWO are located in the deckhouse. The back of the settee swings in to serve as upper bunk

were a snap to put together. But like any good job, the easier it looks the more professional it is.

The boat is roomy and handles easily. For a day, I tried Byrl's boat on Lake Mohave. It was trim, roomy and neat.

The deck chairs fit perfectly on the foredeck. It's a great place just to lounge and watch the passing waters. Or better yet, lounge and troll a fishing line astern.

From the wheelhouse, the pilot has plenty of visibility all around. With louvered windows astern, there's no need for the skipper to wonder what's behind—he can turn and see.

Just behind the helmsman's seat is the galley. There's plenty of room to use the stove (propane), sink and icebox. On the port side, a table and settee can be converted into bunks for two.

Aft of the deckhouse is the main cabin. There are two large permanent bunks, along with the head and hanging locker. Below the port bunk is a 40-gallon water tank and pump for a pressurized water system. And, there's good storage space below the starboard bunk.

Byrl changed the hatch (doorway) leading out onto the rear deck. He did not add the raising hatch which shows in the plans. This means he has a bit more space on the sun deck.

The sun deck is another great place from which to troll. I sat in a deck chair and let my line drift out astern. It's like fishing from the flying bridge of a charter boat.

Tucked neatly away in the center of



UNDER LOWER BUNK are water tank, pump, good storage space



STRINGERS protect bottom when heavy gear is stored in the bow



ANCHOR is kept in hatch under companionway of the deckhouse

the sun deck is the 10-pound bottle of propane. This lasts the Grahams most of the summer—depending on the amount of stove and oven use.

Looking down from the sun deck you can see the powerplants. We are emphasizing the outboard model in the photos here. But the plans do show you how to build the hull to accommodate an in-board/outboard unit and fuel tanks of adequate capacity. The plans also list the amount of plywood, the kind of plywood, the number of regular 2x2s and 2x4s, and the number of stringers you will need.

Byrl coated the inner hull with a heavy coat of clear epoxy. This seals the inner wood, thus lessening the chance of dry rot attacking bare wood. This is especially important in fresh-water operation.

The bottom is covered with regular fiberglass, set in epoxy and coated with an outer layer of epoxy. Byrl has operated the boat a full year. "And still there are no leaks," he says.

One of the best features of this design is the provision of catwalks on either side. These walks give you the exterior space of an 11-foot beam.

All you need do to "shrink" to an 8-ft. beam is to collapse the catwalks. This is the maximum width allowed on most highways, without the need for obtaining special towing permits.

The boat weighs 5800 pounds. Once trailered to water and floated, it will cruise at 10 to 13 knots with a 55-hp outboard. Byrl uses a four-cycle Homelite on the stern.

"I don't want the boat on plane because I'm never in that much of a hurry to get anywhere," he says.

Byrl does add that the boat is not of a deep-sea design. "I've had her out in three-foot waves and that's all I want. But anything under that is okay," he says.

It's true, this is not a blue-water boat; but then few houseboats are, especially in this size.

Byrl says he built the boat for less than \$1000. This is the bare boat. This cost does not include accessories such as power, stove, icebox and head. Neither does it account for trim like drapes and bedspreads. But it does include the material to build the hull, superstructure, sun deck, plus wooden fixtures like bunks, lockers and galley.

Rough estimates call for \$500 for plywood, \$250 for lumber and \$150 for fastenings. An additional \$50 should be included for such items as epoxy glue and fiberglass materials. ★★★

FOR HOUSEBOAT PLANS, SEND THIS COUPON TODAY

Popular Mechanics Service Bureau, Dept. AF
575 Lexington Avenue
New York, N.Y. 10022

Please send me a complete set of plans, materials list, fastening schedule and step-by-step instructions for building the 25-foot trailerable houseboat described in your January, 1969, issue. Also, let me know how I can obtain full-size patterns for a slight additional charge.

I enclose my check (or money order) for \$24.50.

Name (please print) _____

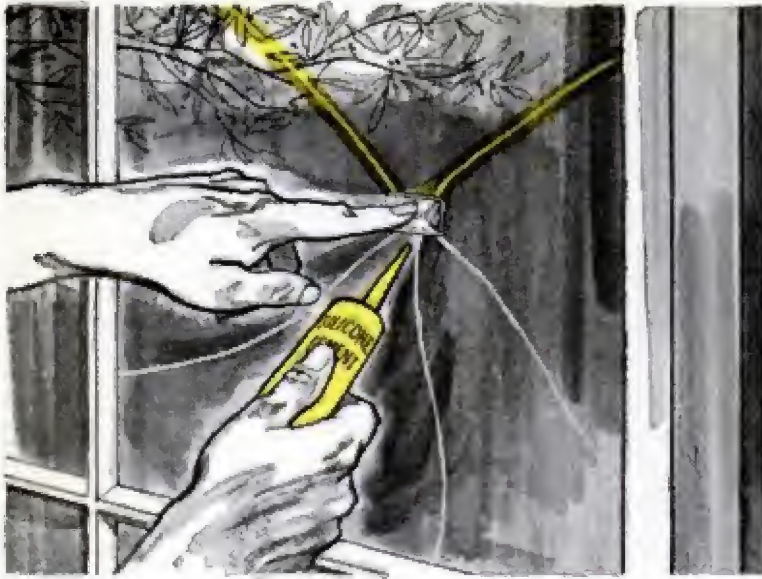
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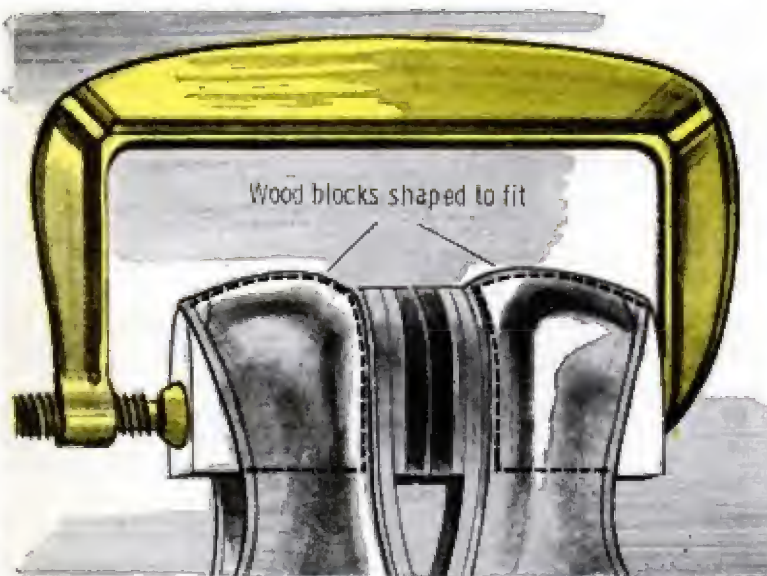
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Solving home problems



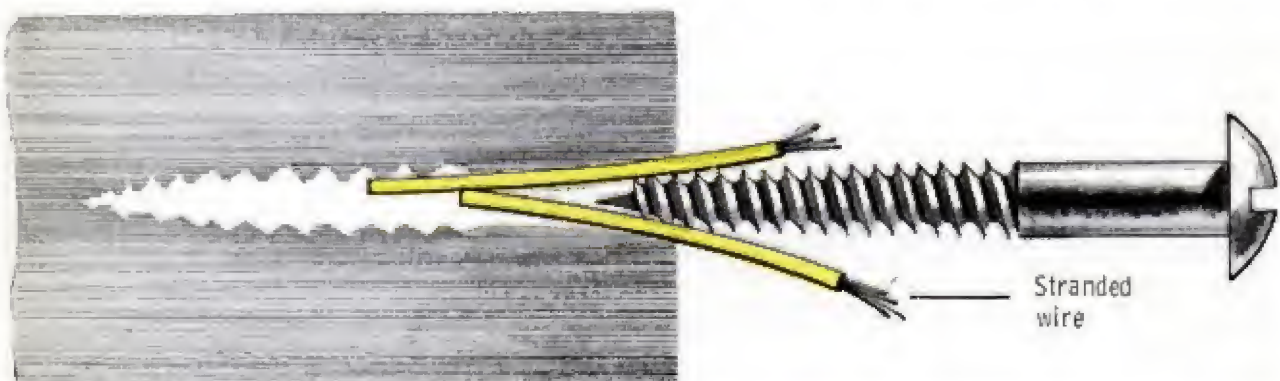
STOPGAP REPAIR for a cracked window can be made with silicone cement. If it's a sunburst crack, first mount a small piece of glass over the center to prevent movement, then seal the rays



YOU WON'T NEED a last or nails to install new heels if you mount them with epoxy cement. Use 2-in. blocks to hold them in C-clamp while drying, then dress the edges with bench grinder



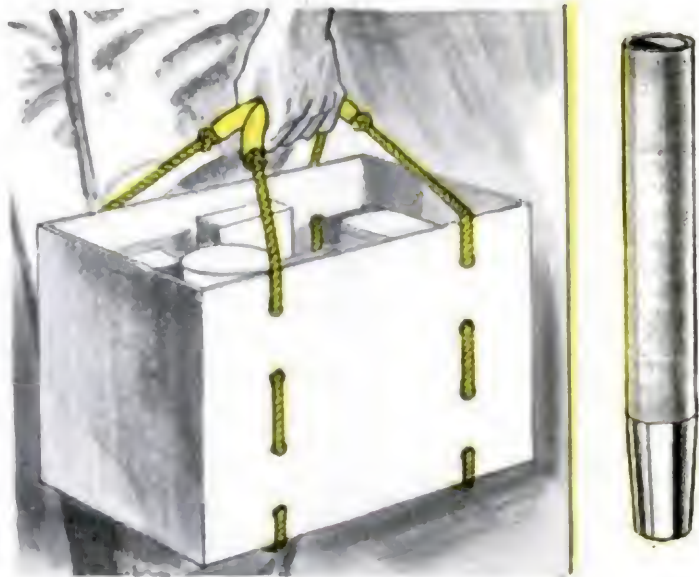
FRUIT PICKER plucks easily bruised fruit from high branches without risk of damage. Just cut a deep V-notch in one side of a 1-lb. coffee can and mount it at the top of a long pole with two screws



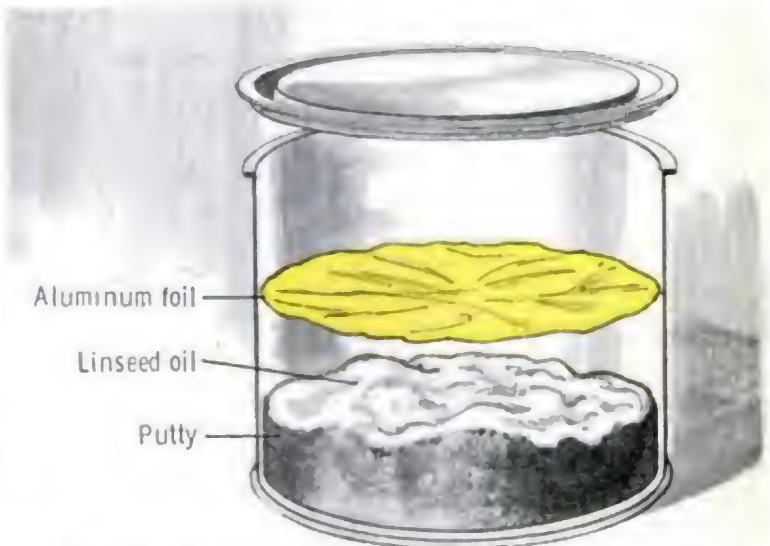
WHEN YOU HAVE TO RESET WOOD SCREWS in the same holes a number of times, they no longer hold as well. To renew the grip, insert short lengths of plastic-covered stranded wire in the threaded area of the holes



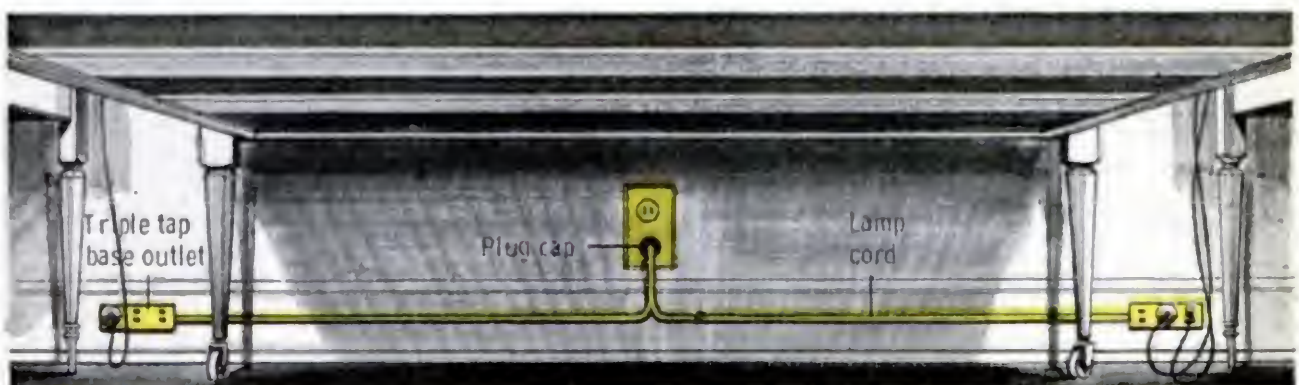
PLUMBER'S FRIEND makes a good mixing container for small batches of spackling compound. It's handy to hold, and the flexible cup is easy to clean, even if some of the plaster should become hard



CARDBOARD CARTONS rigged with rope handles become easy-to-carry tote boxes. Punch holes for rope with $\frac{3}{8}$ -in. pipe ground to sharp edge on one end. Use garden hose for the hand grips



TO PREVENT glazier's putty from drying out, flatten it smooth in the can, brush on a film of linseed oil and press an aluminum foil disc over the surface to replace the original paper disc

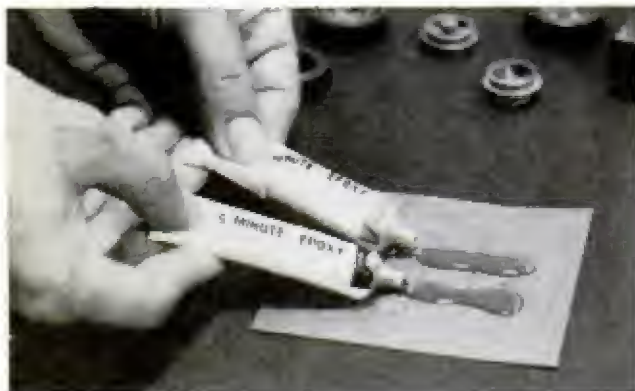


DOUBLE EXTENSION CORD provides outlets on both sides of a bed or sofa. Just cut the plugs from the ends of two triple-socket extension cords designed for baseboard mounting and connect them to single plug

EXCITING NEW PRODUCTS



FIRE EXTINGUISHER can be hung anywhere—even on the living room wall—and not detract from your decorative scheme, when its bright red cylinder is housed in a Dec-O-Cover. Extinguisher and cover by General Fire Extinguisher Corp., Box 326, Northbrook, Ill.



FIVE-MINUTE EPOXY really sets in that time, even at low temperature, dries clear without shrinking, can set while in water. Exact one-to-one mix of this two-part compound is key to successful use. From Devcon: \$1.25 retail.



INDOOR-OUTDOOR VACUUM CLEANER for really tough jobs has been added to the Singer line of home appliances. Model D-5 sells for \$29.95 with utility brush and wand. Five-piece accessory kit is \$10. Also added to the line are two canister and two upright cleaners. Available nationally at Singer Centers.



INDOOR-OUTDOOR CARPET with stylized patterns makes up the new Fiesta line produced by the Ozite Corp. Shown above is the pattern designated as "brick." Available at department, furniture and carpet specialty stores.

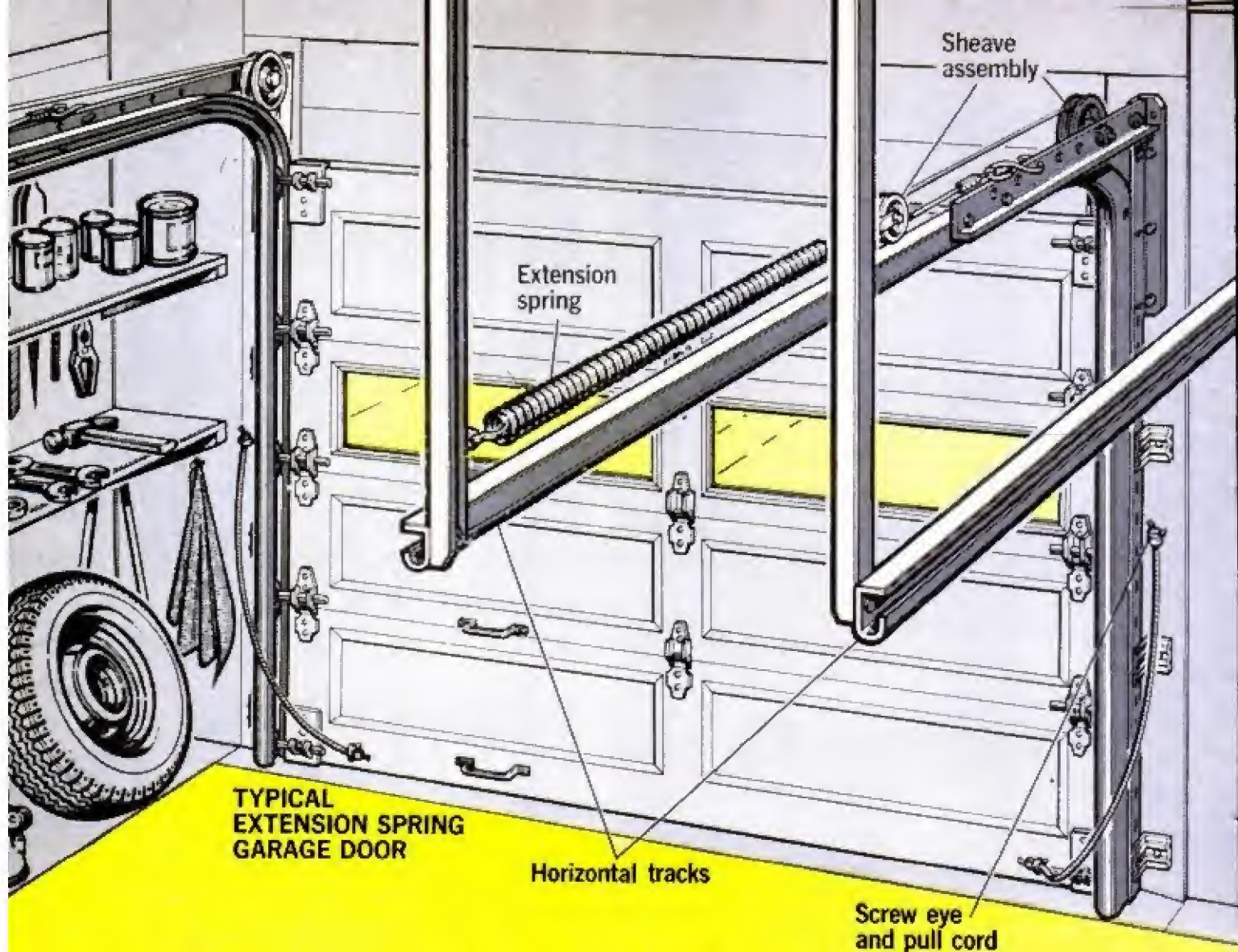


AIR-CIRCULATING PERIMETER HEATER can be the answer to your unusually cold problem areas, since its output varies from 3413 to 4505 or to 5631 BTUs, according to the setting of its built-in automatic thermostat. Corresponding power ratings are 1000, 1320 and 1650 w. Air flow is rated at 30 c.f.m. The unit has a safety feature that will shut it off automatically if it's knocked over. \$36.95 from Arvin Industries, Noblitt St., Columbus, Ind.



RAILROADER LIGHT combines a powerful beam, flashing warning blinker and novel design since it's a replica of an antique railroad signal lantern. It's 8 in. high and weighs $\frac{1}{2}$ lb. Price is \$2.98 postpaid, from Gemael Products, Box 228, Tallahassee, Fla. 32302.

FIRST-AID KIT FOR FABRICS lets you repair burnt holes or small stains in minutes. Called Patch-N-Match, the kit helps you to cut out a circle precisely around the damaged section, fill it with a matching circular patch (cut from a cuff or seam) and seal it in place with a small piece of Thermo-Plastic tape. Included in the kit are a backing tile disc used when cutting the circular patches, heat sensitive tape and cutter. \$5.95 from Sears.



TYPICAL
EXTENSION SPRING
GARAGE DOOR

Horizontal tracks

Screw eye
and pull cord

Keep the Swing In an Overhead

By STEVEN J. HOWARD

SOME PEOPLE never have trouble with their garage doors. Others start having headaches the day the doors are installed.

Why? There are actually eight reasons.

1. Enough forces are working against a door to knock it out of adjustment.

2. Bolts, screws and lags holding hardware can loosen in time.

3. Wooden doors often absorb moisture and get too heavy for simple spring adjustment.

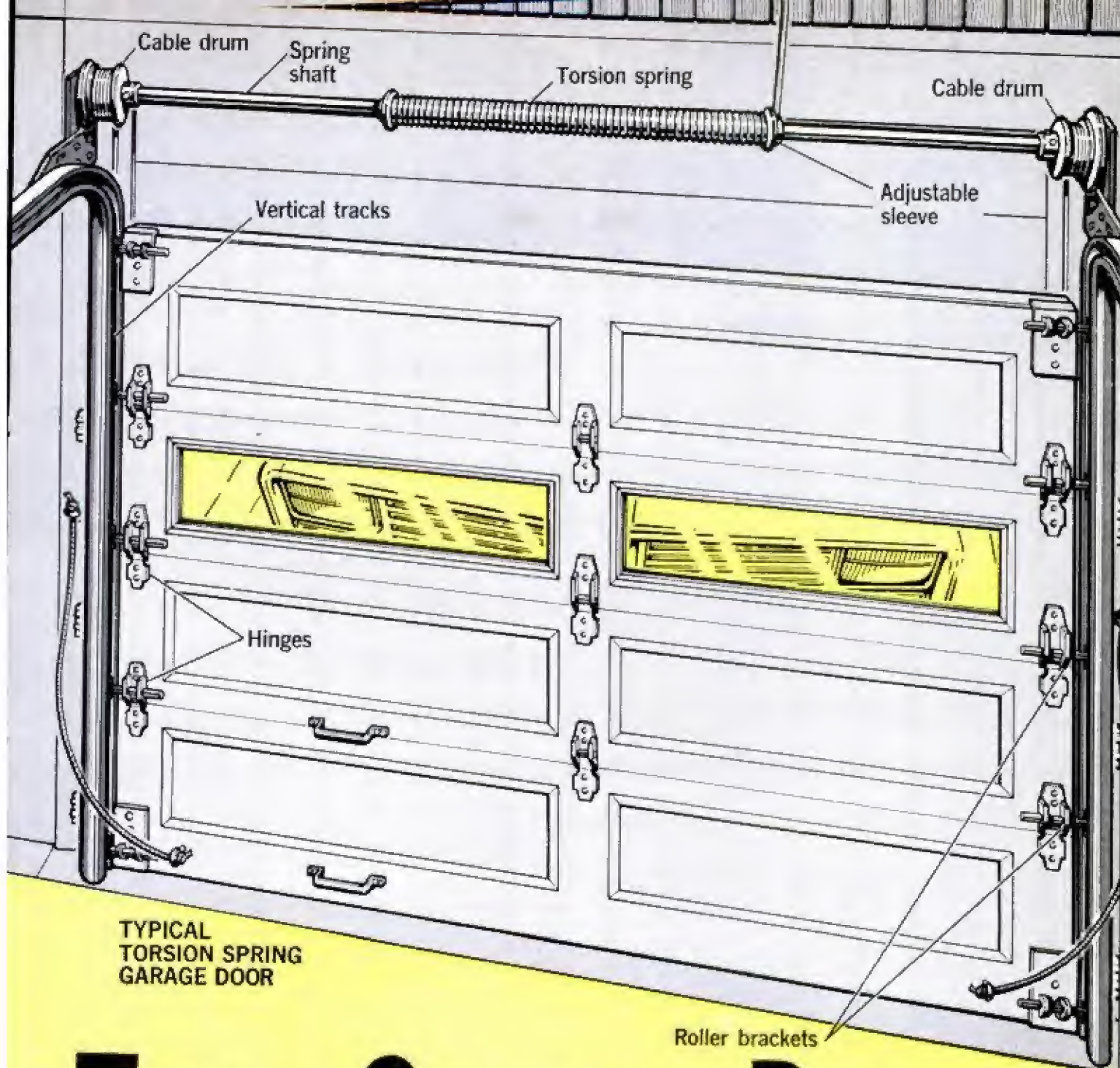
4. Rainy spells will also cause wooden doors and stops to swell, creating binding and friction.

5. Anything added to the door after initial adjustment and balance (such as glass, decorations, even paint) increases weight and can throw the springs out of balance.

6. Dirt in the tracks increases friction.

7. Lack of lubrication or dirty lubricant will also add to door problems.

8. Any physical damage to either the



TYPICAL
TORSION SPRING
GARAGE DOOR

-Type Garage Door

Technical Art by Indugraph

doors or tracks will affect their operation.

These eight factors will affect both extension-spring and torsion-spring overhead-type doors. The extension-spring type, identified by springs along both horizontal tracks, is the easiest to work on—you can repair and adjust it yourself.

The torsion-spring door is identified by torsion springs wrapped around a shaft that can be seen across the top of the door when it is closed. Cables in a torsion-spring setup wind on winchlike drums

attached to the same shaft as the springs.

Here's the only rub—you shouldn't attempt to adjust torsion springs by yourself. According to one door manufacturer, "The only way spring force of a torsion-spring door can be increased is by winding the springs additional turns. This requires two bars to hold the winding plugs. The springs are under tremendous tension and someone who has had no experience in the job can be seriously injured. We recommend a professional if



REDUCING FRICTION between the door and track (left) or door and stop (right) requires bolt adjustment

adjustment is required to any torsion-spring setup, other than oiling and adjusting of hardware."

Before getting to service information I suggest you first get a diagram calling out the specific parts of your particular door. The manufacturer of the door will usually supply it if you give him the right information. Look for a name and serial number plate near the lock. Tell the manufacturer the width and height of the door, its material (wood, fiberglass, steel), model name (if available), serial number and approximate age.

Now let's take each major door problem and see how to handle it.

Friction, for instance, is the most prevalent. To cure it, use a fairly heavy grade of oil (No. 20 is best) on pulley, ball bearings, door rollers and hinge pins. Only a few drops are needed at each point.

Roller shafts should be free to slide back and forth in the roller bracket. Many manufacturers recommend general-purpose Lubriplate, available through automotive stores, since it's waterproof and unaffected by weather changes.

Another lubrication spot you shouldn't miss is inside the track where the rollers slide, especially around curved portions.

Should lubrication fail to solve the

friction problem, check the door and door stops to see where and to what degree paint has been rubbed off. If you find evidence of excessive rubbing, you have two alternatives: You can move the stops away from the door if rubbing is localized in one or two areas, or you can move the door away from the stops if it is a general problem—that is, if rubbing occurs along most of the contact surface.

In the latter case, examine the hardware alongside of each track. Brackets holding the track away from the door may be spot-welded and not adjustable, or attached with bolts and fully adjustable.

If you have a door with adjustable brackets, loosen the bolts holding the track, pull the track toward you about $\frac{1}{8}$ in. and tighten the nuts. This will usually alleviate the problem. If you find friction localized to a few smaller areas, plane the stop to remove high spots.

It is important to have $\frac{1}{4}$ to $\frac{1}{2}$ in. of side play between door and tracks at any position, open or closed. You should be able to float the door from side to side $\frac{1}{4}$ to $\frac{1}{2}$ in. If not, the tracks may be too close to the door edge and bind the rollers.

To adjust, simply go back to the track brackets, back out the lags a few turns and move the tracks farther apart. Make



COMMON WAY to adjust spring tension is to change S-hook placement. Vise clamp keeps door from falling

sure tracks are vertical and evenly spaced by checking with a carpenter's level.

Spacing tracks too far apart is not a good idea. This could permit one side to reach higher than the other during open cycles. The condition, called "racking," wedges the door in the track and stops it.

Now we come to the overweight door. Tip-offs to a moisture problem are surface checks and small cracks in panels. Springs can be adjusted to compensate for added weight, but during a dry spell you should thoroughly sand panels and repaint *both sides* with a quality exterior paint.

Adjusting for weight is done by putting more stretch in springs. But remember—do this only on extension-spring doors.

Most extension-spring doors are adjusted from the cable's dead end fastened to the horizontal track reinforcing member near the door opening headers.

No matter how springs are adjusted, the door must be opened and propped, since springs will be detached and the door can fall. Prop the door open with clamps or by putting a strong ladder beneath it.

Many doors are anchored by S-hooks. To increase spring tension, first move one hook forward a few holes, then move the hook on the other side the same amount.

On some doors, spring adjustment is

made by moving the back end of the extension spring over a notched bar. On still others, adjustments are made with an eyebolt and nut through the rear track hanger.

Next check for the proper balance point. With the bottom of the door 1 to 2 ft. off the floor, it should neither tend to raise or fall by itself. Above this position, a well-balanced door will tend to rise slowly by itself. Below it, the door should fall by itself.

If it's no longer possible to balance the door with the present springs, they should be replaced with stronger ones. If you can identify the make of door, you can probably get them from a dealer. If not, weigh the door (detach the springs and lower the door onto a bathroom scale placed under the center of the door).

You'll probably need help. A one-car garage door weighs up to 150 pounds; two-car sizes weigh 300 pounds and more. When you know the weight, ask a dealer to get workable springs for you.

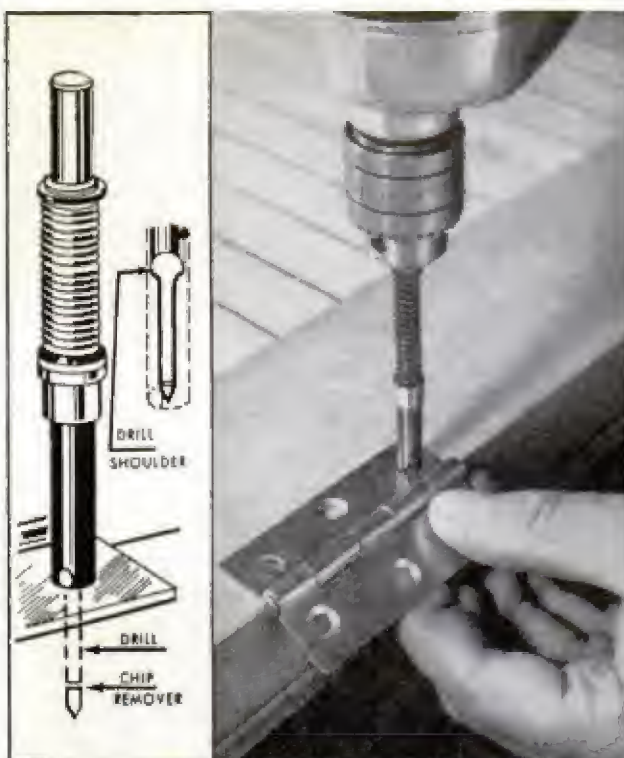
To keep a working door troublefree, lubricate all moving and turning parts once every six months. At that time, tighten all loose bolts, check the cables for fraying or wear and make sure one hasn't slipped off its sheave. ★ ★ ★

New Tools You Should Know About

CENTER-SINK for installing all types of hardware automatically centers and drills screw pilot holes accurately and in one operation. Thus, installing hinges, latches, drawer pulls, cover plates, door knobs, marine hardware and kickplates becomes a simple job, even when you're working with stubborn cross-grained hardwoods.

To use it, just place the guide tube in the hole of the plate or hinge, then start the drill and apply a light pressure so that the turning drill bit will be centered exactly. Then continue to apply this pressure to overcome the spring resistance of the center-sink tool until the drill has completely bored into the work for its full length.

Never bear down heavily on the pilot hole locator, and always withdraw it while it is still turning. Install one screw to hold the plate or hinge securely in place before drilling the other pilot holes. A set of three for No. 4 to No. 12 screws sells for \$4.45 from Norfolk Products Corp., Winsted, Conn. 06098.



FAST-CUTTING RASPS in 3 different styles have a 10-in.-long cutting surface with over 1000 individual teeth for easy working with common workshop materials like wood, plastics and soft metals. The flat rasp is ideal for such tasks as planing, beveling, sanding and filing flat objects, while the curved rasp has a convex cutting surface especially useful for shaping concave or contoured surfaces. The hole rasp has a circular shape and can be used either for enlarging holes or for shaping sharp curves. Price for each of the first two is \$1.98, while the last costs \$1.68. All three are available at retail outlets, or for \$4.75 postpaid from Arco Tools, Inc., 421 West 203 St., New York, N.Y. 10034.



DRILL STAND for portable electric drills will let you convert most any $\frac{1}{4}$ or $\frac{3}{8}$ -in. portable drill to a handy bench motor for such indispensable operations as grinding, buffing, sanding, sharpening or wire brushing. It's constructed of sturdy polystyrene and features a stainless steel, quick-adjusting clamp that will firmly hold and lock the drill in place when mounted on a workbench.

The drill stand can be especially useful whenever a flexible shaft must be fitted to the drill. Four screws and washers are included for easy mounting of the drill stand to your workbench. Price of the No. 4511 stand (shown at right) is \$1.50. It's available at retail hardware stores or you can order it directly from the manufacturer, Coastal Abrasive and Tool Co., Inc., Box 337, Trumbull, Conn. 06611.

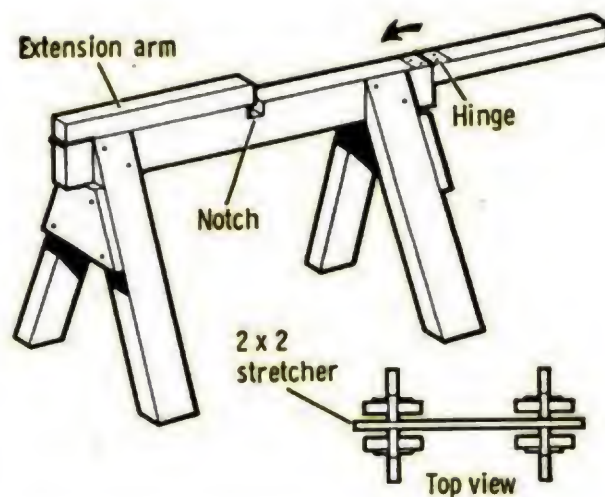


HINTS FROM READERS

Increasing sawhorse capacity

Working with 4x8-ft. sheets of plywood or paneling can be quite awkward—but not when you have a pair of these modified sawhorses. As shown, there are two hinged extension arms added to the top crossbar to increase its 24-in. width to 4 ft. The second change is the notch in the crossbar to accept a 2x2-in. stabilizing brace or stretcher running from one horse to the other.

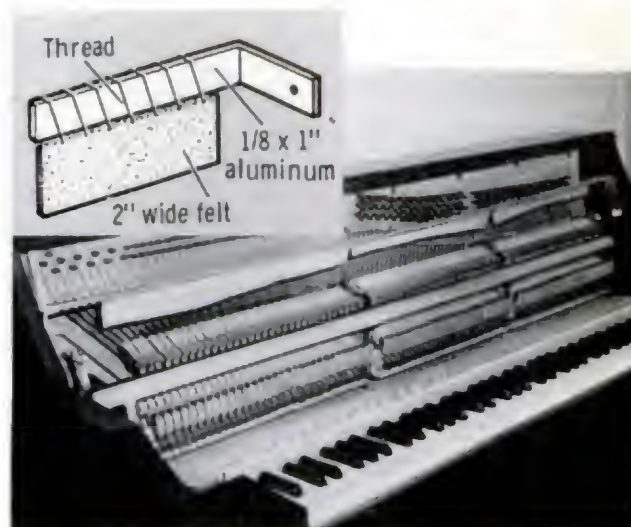
—Dr. John A. Walker



Piano muffler

If your children's piano practice is limited to those hours when no one's home simply because it's more noise than music, fit this quick-switch muffler to the piano and allow the kids to play as long as they like. As shown, the muffler is merely a 1/8-in.-thick piece of felt that's threaded to an aluminum crossbar. The felt slips behind the hammers to absorb most of the force, yet allows a full, soft tone without sacrificing tonal graduation. When the muffler isn't needed, simply pivot it upward out of the way.

—Roderick R. Hall



Simple lock control for electronic garage-door opener

As a long time enthusiast and owner of automatic garage-door openers, I enjoyed the article *How to Install Your Own Garage-Door Opener* (page 171, April '68 PM). There are few things indeed that, once used, change suddenly from the category of *luxury* to that of *absolute necessity*.

I have, however, one suggestion. I have yet to see a radio-controlled, garage-door

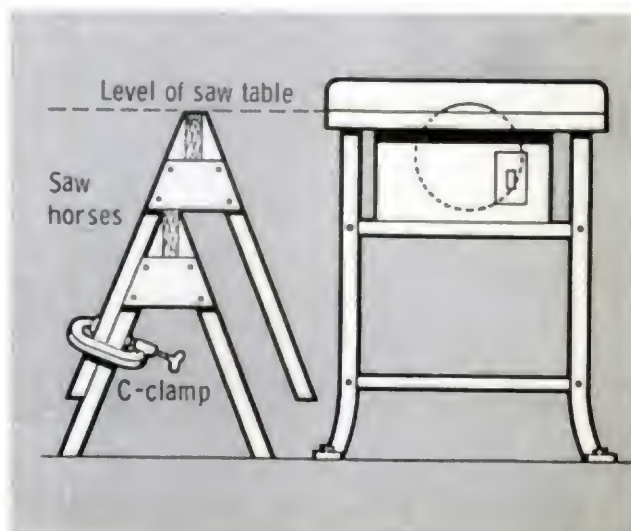
opener that is not occasionally subject to phantom operation; that is, a random signal may open or close the door. To reduce the chances of my door opening, I've included a switch in the 115-v.a.c. line to the operator. At night, or when I'm away on a trip, I flip the switch off—and rest secure in knowing that only a heavy crow-bar and inordinate brute strength will open my garage door.

—H.L. Lynch

Pair up horses for height

The next time you find yourself trying to manhandle a 4x8-ft. sheet of plywood or a long board on a table saw, try this trick. All you need are a pair of sawhorses, a pair of C-clamps and a minute or two of work. Place one horse on top of the other and clamp the legs together as shown in the sketch. In the event you find that the sawhorses become top-heavy and tend to tip forward, try canting the top horse so that one leg on either side contacts the lower horse; i.e., in the view at right, one clamp will be on the left and the other on the right.

—John Hilden



How to Squeeze More Storage

Put wasted space to work with these simple projects that make stowage a cinch

By D. SWANSON

WANT TO BE THE REAL HERO of the family? Then turn the high-traffic room of your home, the kitchen, into a comfortable, livable and highly efficient area—simply by incorporating just a few of these storage ideas in it or by building in two or three of these work-savers.

What's more, they're all uncomplicated enough to be tackled one or two at a time each winter weekend so that by the time spring rolls around, the value of your home will have increased considerably—dollar-wise as well as convenience-wise.

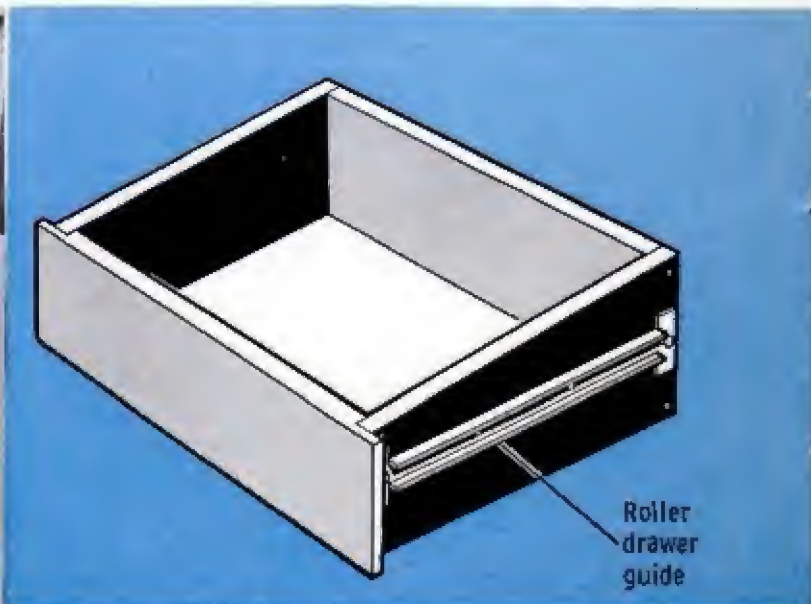
One such convenience feature is the storage area for rolled tablecloths (shown at the left) while another is a pair of simple drawers (below) used exclusively for pans and trays that are too awkward to store in a conventional fashion.

These and additional spacesavers (and space-makers) were found originally in the home of Mr. and Mrs. Frank Myers of Winston-Salem, N.C. Although Mr. Myers



CAREFUL SEARCH FOR HIDDEN SPACES usually will yield two or three areas that can be effectively utilized for storage of odd items. In this case, a long space was found for tablecloths wound on tubes

SIMPLE DRAWERS AND PULL-OUT RODS can be used to store pots and pans compactly within easy reach



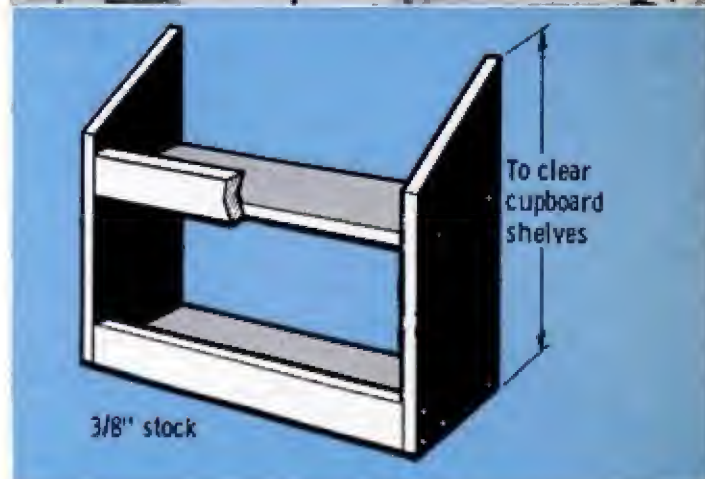
Space Out of Your Kitchen

is in the electrical supply business, the couple's specialty is finding simple solutions to big problems. Their island unit, for example, has a triple sink and stainless steel top; it could be installed easily in the wasted space in the center of an average kitchen. It also offers the bonus feature of providing enough under-the-sink space to hold trash cans and cleaning supplies. A pull-out Formica-topped shelf rests hidden in the island until needed, while a separate, but nevertheless handy, cutting board is similarly built-in next to the sink.

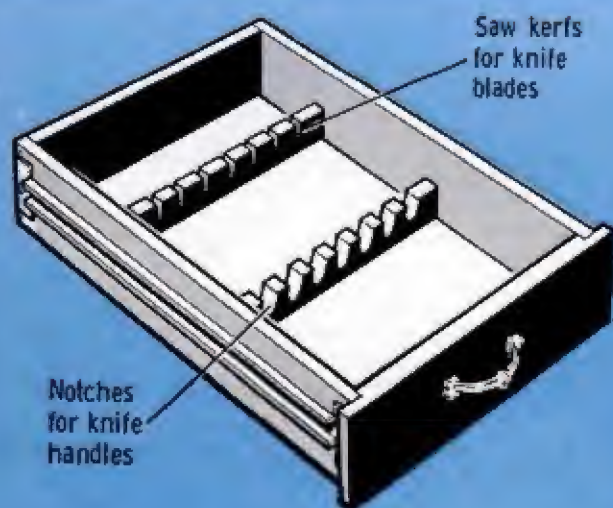
The cabinets around the perimeter of the 12 x 14-ft. kitchen also were designed with livability in mind. With careful planning, the Myers were able to transform a single 12-ft. wall into more than 300 ft. of shelving. To the right of their refrigerator, for example, four standard-size doors open to uncover a broom closet and shallow pantry type storage. Three of the doors are lined with shelves and three deep drawers at the bottom hold odd-sized containers, supplies and bottles.

In fact, there are drawers and shelves neatly tucked away in nearly every cabinet. In one, a linen drawer replaces the

SMALL BOTTLES OF SPICES can be neatly arranged in a simple rack fitted to inside of a door. Two or three of such racks will do for entire kitchen



KNIFE DRAWER with two shaped cross members will stow knives out of sight, protect them from damage



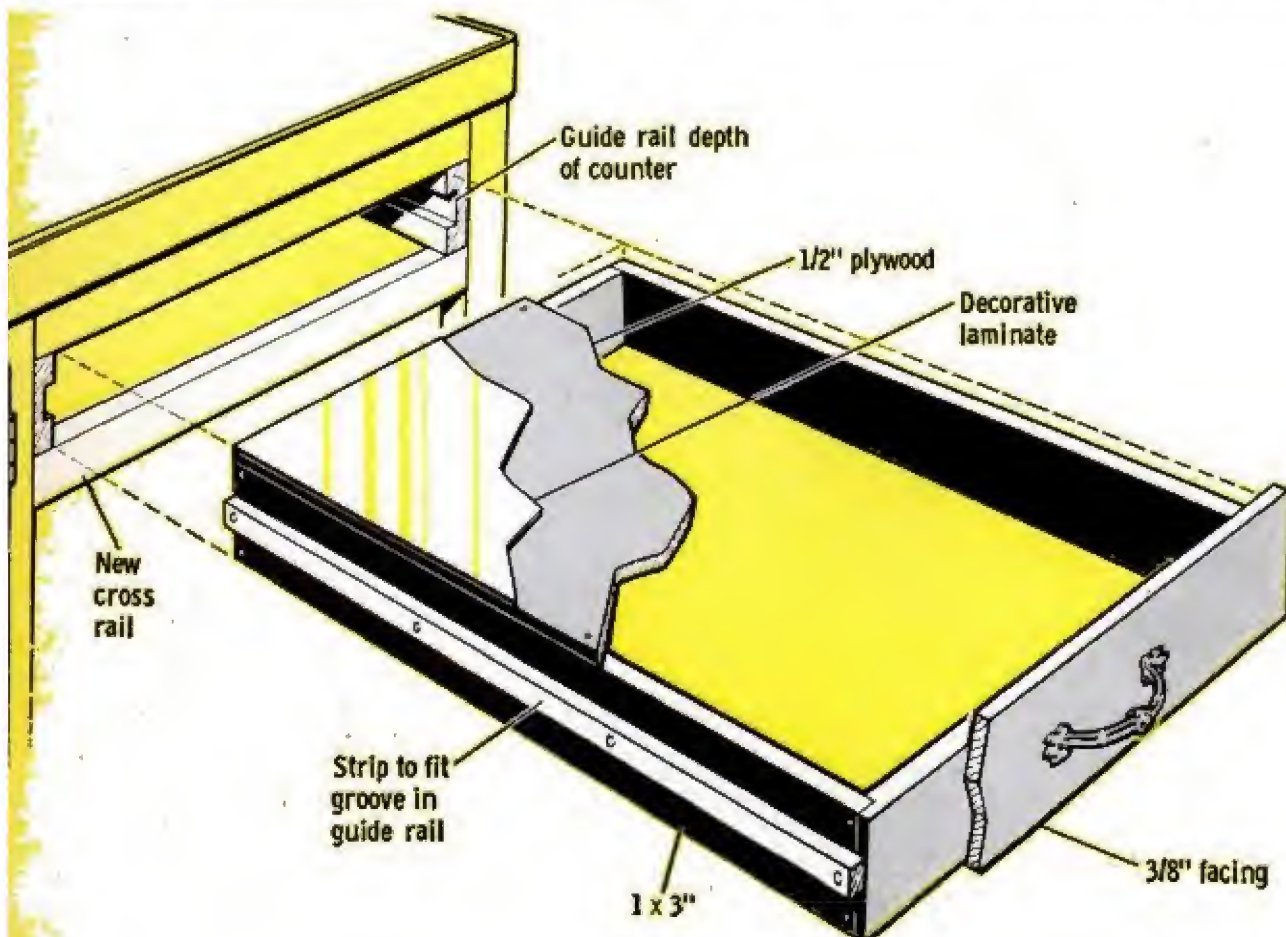


bottom shelf; in another, two drawers hold large pans and pan covers; while in a third, pull-out racks hold pans with handles in a vertical, spacesaving position. Thus, the spacemakers are also backsavers since it's possible to reach any item without resorting to kneeling or bending over for more than a few seconds.

In most kitchens, it's usually possible to find hidden or otherwise wasted space that could be put to effective use as a storage area. The Myers, for example, discovered unused space above the airconditioning unit installed between the garage and their dining room. Since the space ended at the kitchen wall, it was a relatively simple chore to cut an opening in the wall and build in a long shaftlike cabinet to hold tablecloths rolled on cardboard tubes. A careful study of the plans of your home likely will reveal a similar space between the walls of additions, at the back of deep closets or around stairways and built-in appliances.

Other special-use spacesavers that you could easily build into your kitchen take

HANDY CUTTING SURFACE is easy to build and install. It's basically just a bottomless drawer fitted with a top that will hold up under a knife blade



the forms of spice racks, knife drawers, bread bins and multi-shelf units used strictly for canned or bottled goods. Here again, the trick is to search out unused space and put it to work—preferably using it to solve the problem of storing awkward, bulky, shelf-robbing items such as toasters, mixers and similar appliances.

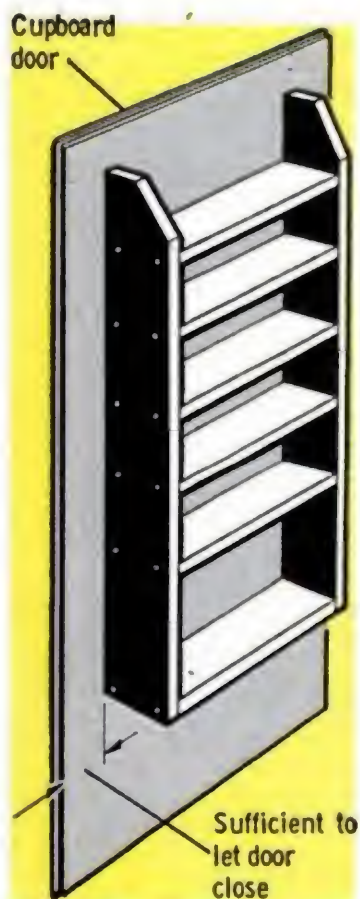
Combine these simple kitchen aids and worksavers with such conveniences as lighting fixtures concealed under the cabinets and adequate electrical outlets, and you'll find that your once-congested kitchen will be transformed into a highly organized, highly livable center your wife will be proud to show—and use efficiently.

Yet, as previously pointed out, you can make these additions and changes gradually and without great expense since you likely have enough odd pieces of lumber left over from old projects to complete five or six of these weekend projects at your leisure. Also noteworthy is the fact that it's not necessary to tear up the kitchen and disrupt its use during this modernization program. And at completion, you should look forward to the biggest, thickest steak ever. ★ ★ ★



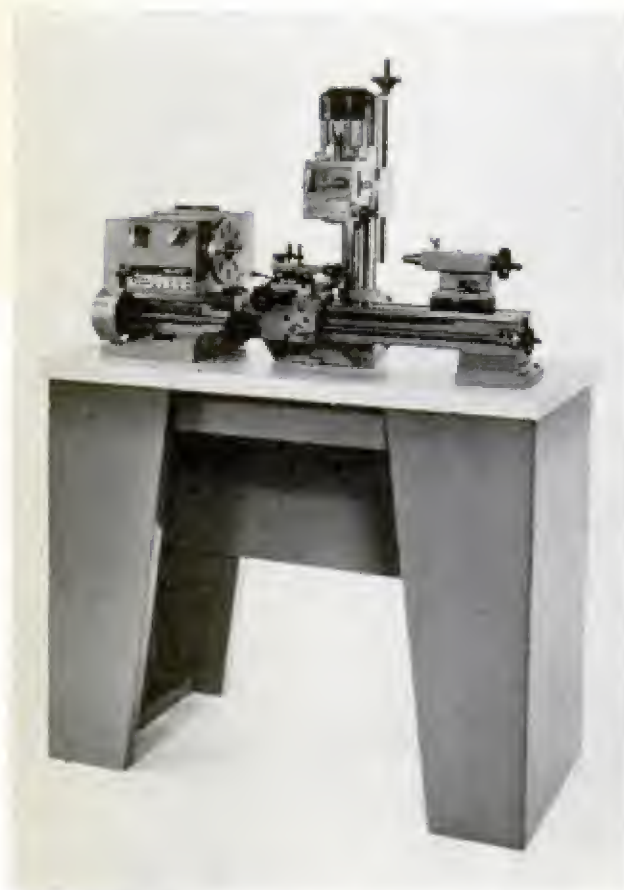
ROLL-OUT BINS placed in bottom of cabinets are for storage of kitchen towels and cleaning supplies; eliminate need to kneel just to remove item in back

PANTRY SHELVES built on doors can provide storage space that's ideal for canned and bottled supplies



Build This Box-Leg Power-Tool Stand

By JOHN BURROUGHS



STAND IS IDEAL for a lathe. Finish the underbody with machine-gray enamel and leave top unfinished

THOUGH IT'S MADE from economical low-grade lumber, this solidly built tool stand is rugged enough structurally for the heaviest machine in your shop. With a single power tool and a vise it makes a fine combination stand-work-bench. If you already have a bench, you can install two power tools side by side and turn it into an attractive double-length machine stand.

Length and width should be matched to the tool or tools you plan to install on the stand. To make the understructure, build two identical box-leg assemblies. These are joined with a 2x4 front rail and a 20-in.-deep back panel of $\frac{3}{4}$ -in. plywood. Glue and nail all joints.

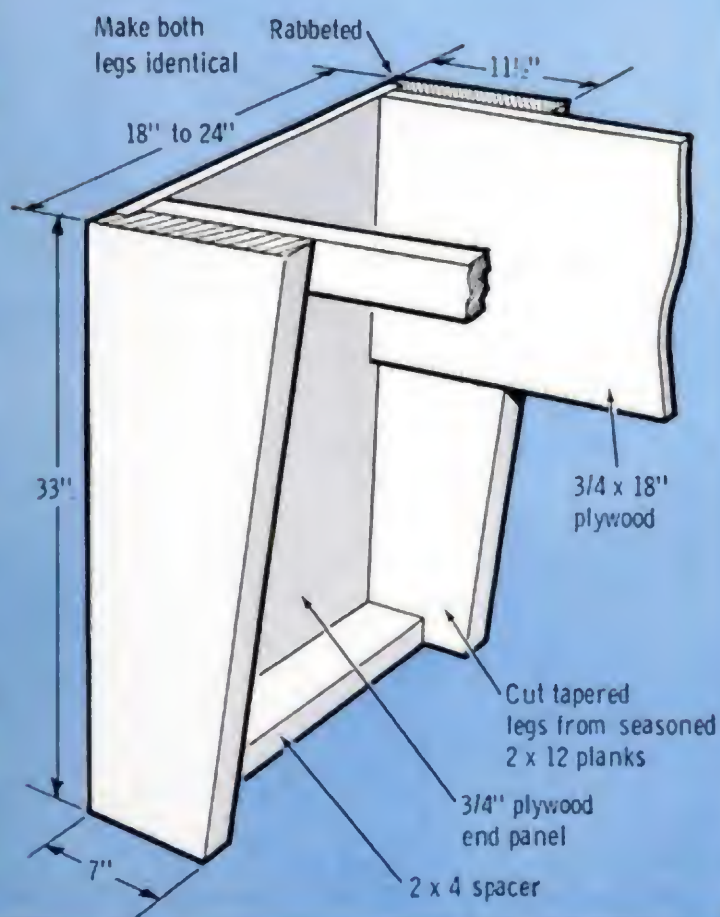
The slab top can be either doubled $\frac{3}{4}$ -in. plywood edged with strips of oak flooring or $1\frac{1}{2}$ -in. hard maple, edge-glued and cross-bolted. Dimension it to overhang the base about $\frac{1}{4}$ in. on all sides.

When mounting a lathe, grinding head, bandsaw or other tool that should be belt-driven from underneath, hang the motor inside one of the box legs and cut slots in the top for the belt. ★ ★ ★



JOIN BOX LEGS with a 2x4 rail in front and a plywood panel in rear. Glue and nail all joints securely

BOX-LEG ASSEMBLY



HINTS FROM READERS

File-card contour gauge

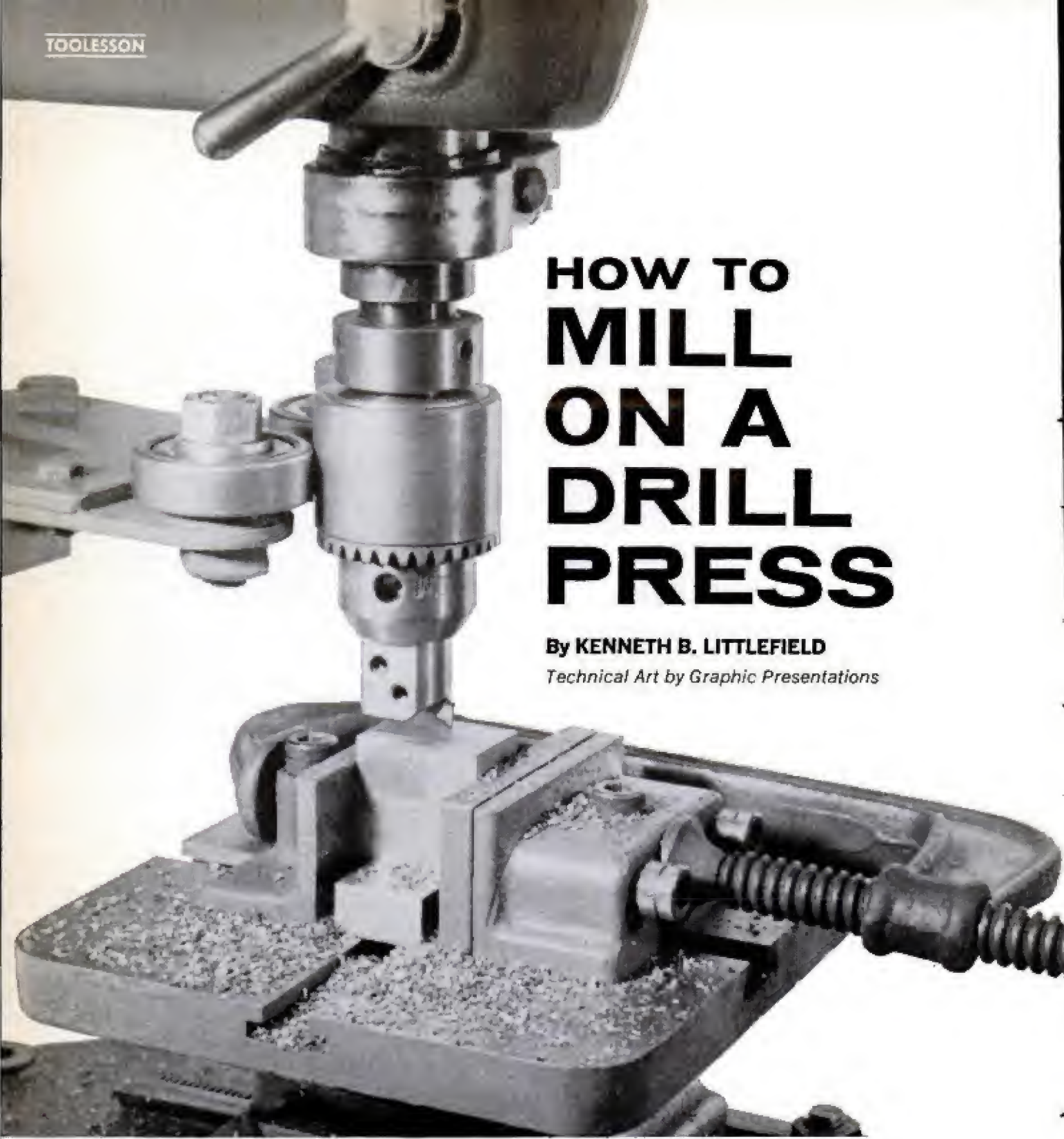
The next time you have to copy a contour or curve, try this fast and foolproof method. Just take a stack of 3x5-in. file cards, wrap a thick rubber band around the length of the cards and force the cards down around the contoured surface. Then snap a spring-type stationery clamp over the width of the cards to hold the duplicate contour. Be sure, however, that the cards are kept tight to prevent them from spreading.



Lathe-center tester

Cut a disc from the bottom of a tin can and you have a handy tester for checking lathe-center alignment. If the centers are properly aligned, the disc will remain at right angles to the lathe axis when lightly clamped between the pointed centers. If the tailstock center is shifted, the angle will not be 90°. Of course, the disc must be flat, and the points should not contact it on an embossed letter or figure.





HOW TO MILL ON A DRILL PRESS

By KENNETH B. LITTLEFIELD

Technical Art by Graphic Presentations

These simple cutting attachments will make it possible for you to mill metals, such as aluminum, cast iron and steel, on your drill press

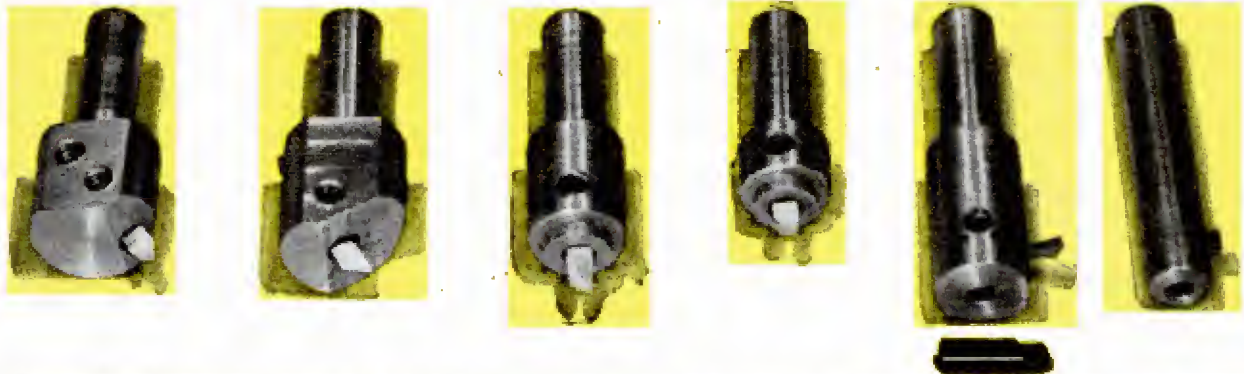
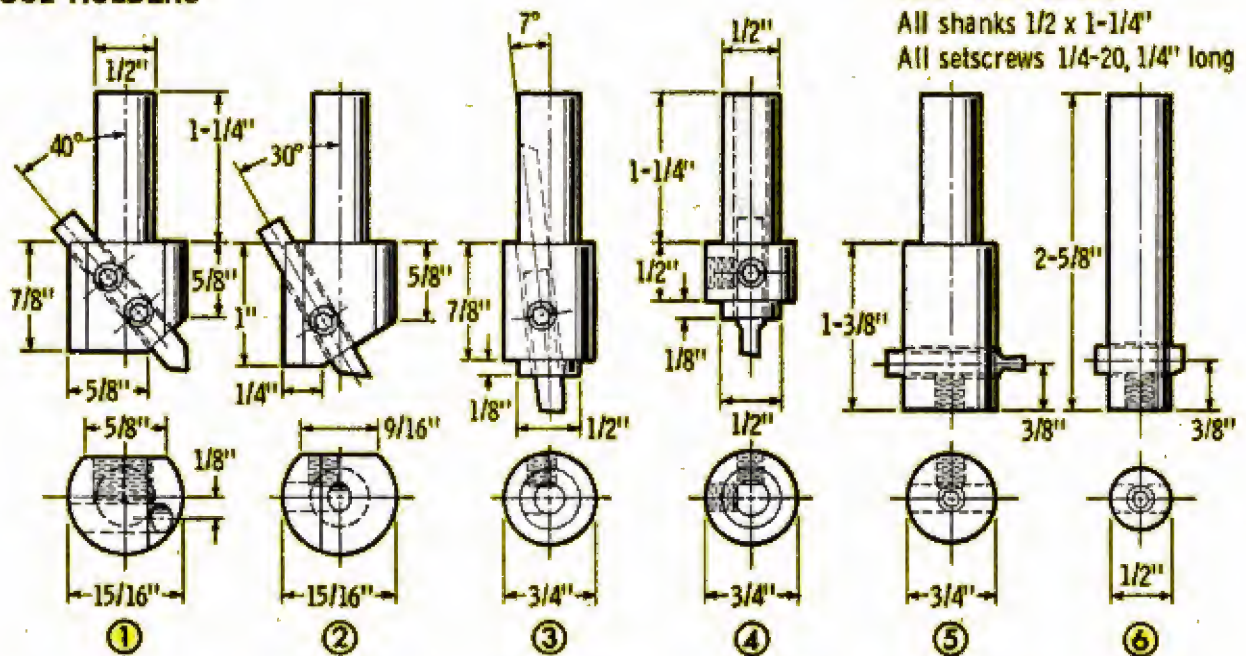
COMBINE ANY MILLING VISE with the cutters and spindle support attachment shown here and you can convert your drill press into an excellent light-duty milling machine.

Use of fly cutters instead of multi-tooth commercial milling cutters makes drill-press milling practical for the home-workshop craftsman. These fly cutters are

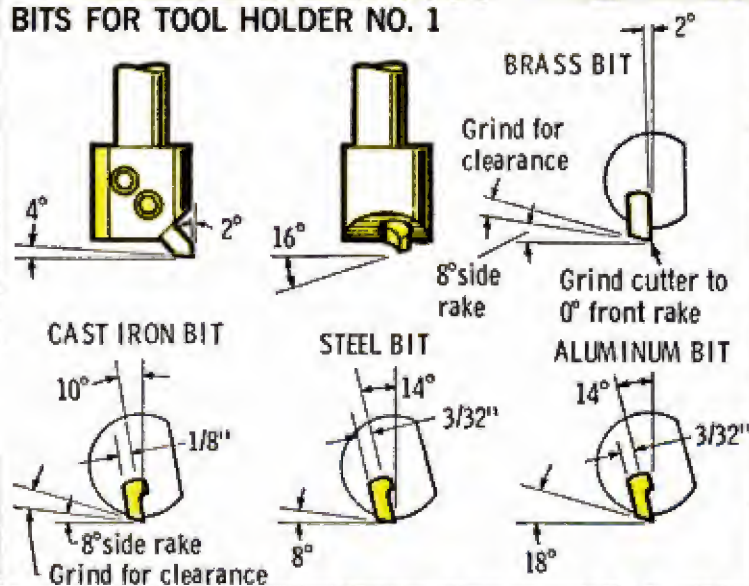
inexpensive $\frac{3}{16}$ -in.-sq. lathe tool bits fitted in vertically mounted toolholders. You can keep them sharp without special grinding equipment and can change cutting angles readily to suit the metal being milled.

However, these fly cutters *must never be used without the spindle support attachment*. If the workpiece is advanced too

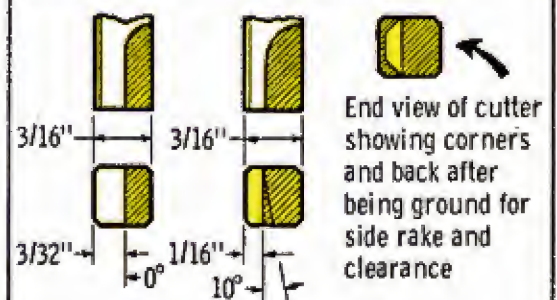
TOOL HOLDERS



BITS FOR TOOL HOLDER NO. 1



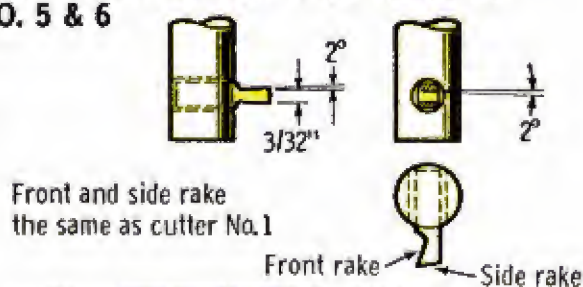
BITS FOR HOLDERS NO. 2, 3 & 4



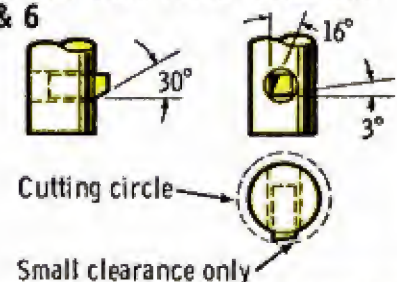
Front rake is obtained by reducing thickness of tool bit

Rake angles the same as those for Bit No. 1

KEYWAY CUTTER FOR TOOL HOLDERS NO. 5 & 6



BORING BAR FOR TOOL HOLDERS NO. 5 & 6



SPINDLE SUPPORT ATTACHMENT

Side View Dimensions:

- Top flange width: $5\frac{1}{8}"$
- Top flange thickness: $1\frac{3}{8}"$
- Bottom flange thickness: $1\frac{3}{8}"$
- Distance between flange centers: $6\frac{1}{4}"$
- Distance from top flange center to mounting hole center: $3\frac{1}{2}"$
- Overall height: $4\frac{1}{4}"$
- Overall width: $7"$

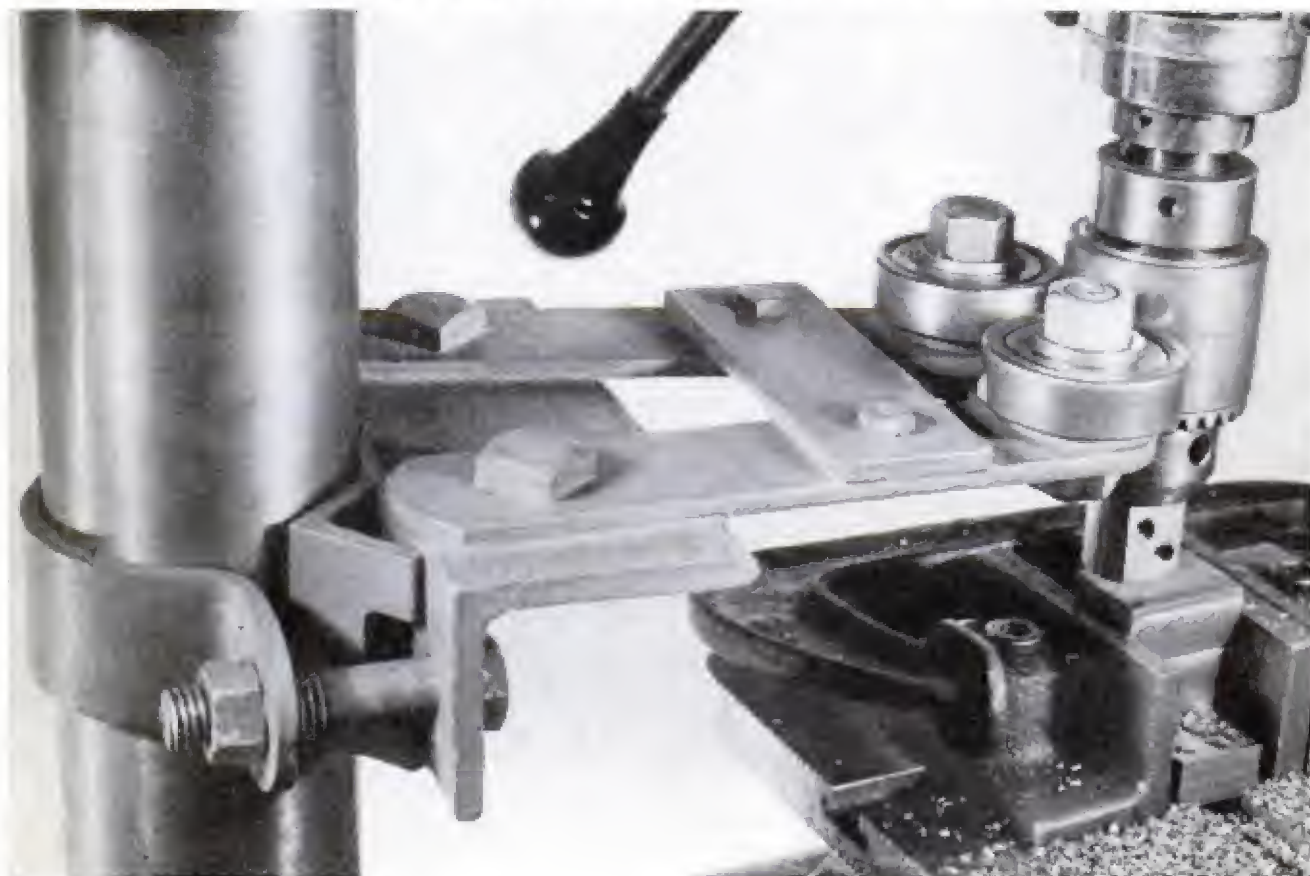
Components and Assembly:

- Weld:** $\frac{3}{16} \times 1\frac{1}{4} \times 1\frac{1}{4} \times 2"$ angle iron
- 3/16 x 1-1/2" strap iron** 8" long
- 1/4 x 3/4" machine bolt**
- 1/2 x 1" machine bolt**
- 1/4 x 2 x 2-1/2" angle iron**
- Cut out to clear bolt**
- 1/2 x 2-1/2" machine bolt**
- Work face of bearings**

Bearing Detail Dimensions:

- Ball bearing:** $1\frac{7}{8}"$ dia., $\frac{3}{4}"$ bore
- Washer:** $\frac{1}{2}"$ i.d., $1"$ o.d.
- Nut**
- Push fit to bearing:** $\frac{1}{2}"$ dia., $1\frac{1}{4}"$ dia., $\frac{1}{2}-13$ thread
- Square nut**
- To fit bearing:** $\frac{1}{16}"$, $\frac{1}{8}"$

FITTED ON DRILL-PRESS COLUMN, spindle support will prevent deep bites of bit from bending chuck spindle





EASY WAY TO CUT BLANK TOOL BIT to the desired length is with a $\frac{1}{8}$ -in.-thick abrasive cutoff wheel



NEXT REDUCE THE THICKNESS of the blank bit on a bench grinder. Dip in water to avoid overheating



PLACE THE BIT IN ITS HOLDER and continue to grind it to approximately the correct size and shape



CAREFULLY FINISH GRINDING the fly-cutter bit by adjusting the grinder's toolrest to the required angle

rapidly, or it slips in the vise, the cutter will strike powerfully against the work. The spindle support absorbs the force of this blow, so no damage will result. Without it, the drill-press spindle would probably bend and be permanently damaged.

The spindle support shown is for a drill press with a $2\frac{3}{4}$ -in.-diameter column. Exact size of the two ball bearings isn't really important. Heavier steel can be substituted for that in the drawing; lighter metal definitely should not be used.

To set up the attachment, clamp the base to the drill-press column and attach both arms and bearings to the base. Swing them in until the bearings press firmly against the side of the drill-press chuck, then bolt the cross brace in position.

Turn the toolholders from mild steel and cut flats on two faces of the holders to facilitate boring holes for the cutter bits and setscrews. Later, corners of the tool bits must be beveled slightly to fit the $\frac{1}{4}$ -in. holes in the holders. The No. 1 toolholder is bored offcenter to simplify

grinding the rake angle of the bit; that is, a front rake of up to 14° can be obtained simply by reducing the thickness of the bit. Except for the keyway cutter, a front rake is obtained similarly in the other cutters by reducing the tool bit thickness. A rake of about 10° can be had without weakening the tool bit. The keyway cutter is ground like a lathe tool.

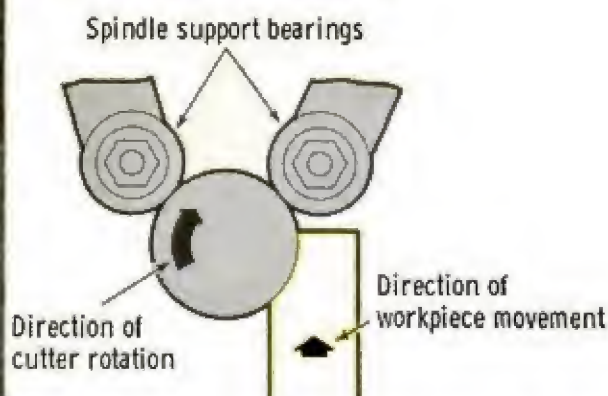
Rake and clearance angles shown in the drawings are the actual working angles of the cutters when held in the toolholders. To avoid confusion, hold the blank tool bit in its holder as you grind.

With the drill press running at its slowest speed, make a trial cut. The cutter should produce small, neatly formed chips. If not, check for sufficient side rake and regrind if necessary. If it still refuses to cut, it is because of insufficient front rake (especially when milling steel).

If the cutter seizes into the metal, accompanied by considerable vibration, reduce the side rake. With brass and to a lesser extent, gray cast iron, this effect



METHOD OF MAKING CUTS



TO MAKE SLOTTED CUTS, first remove the bulk of the material with a series of drilled holes. Then fit drill press with the cutter and feed the work into the bit, in direction indicated in the drawing directly above

can also be caused by too much front rake. Bottom clearance and rake have little effect on the cutting of the bit but will affect the finish of the work.

The cutting speeds listed below are suggested only as a working basis. Too fast a speed rapidly wears away the tool's cutting edge; too slow a speed increases vibration and leaves a rough finish.

Cutter No.	1	2	3 & 4	5 & 6
Aluminum	1600	1000	2000	1000
Brass	1000	1000	1500	1000
Cast Iron	500	500	700	500
Annealed				
Alloy Steel	750	400	750	400
Mild Steel	1000	705	1000	750

The depth of cut with the large cutters should not exceed $\frac{3}{32}$ in., while the small cutters are limited to $\frac{1}{16}$ in.

Aluminum, brass and gray cast iron should be milled dry, as can be mild steel, but thread-cutting oil will help retain a sharp edge on the tool bit. Also use this oil when milling annealed alloy steel.

Cutters 1, 3 and 5 are sufficient for most milling jobs. No. 2 is useful for milling

small dovetail slides but it is suitable only for light work. No. 4 is particularly useful when working with soft metals.

Cutters 5 and 6 can be used either as keyway cutters or boring bars for enlarging existing holes. In the latter case, the optimum cut is about $\frac{1}{32}$ in., and the cutter must be fed into the work very slowly to avoid vibration. The best cutting speed will vary according to the hole diameter, but should not exceed 800 rpm for a $\frac{5}{8}$ -in. hole or 350 rpm for a $1\frac{1}{4}$ -in. hole. Cutting oil should be used.

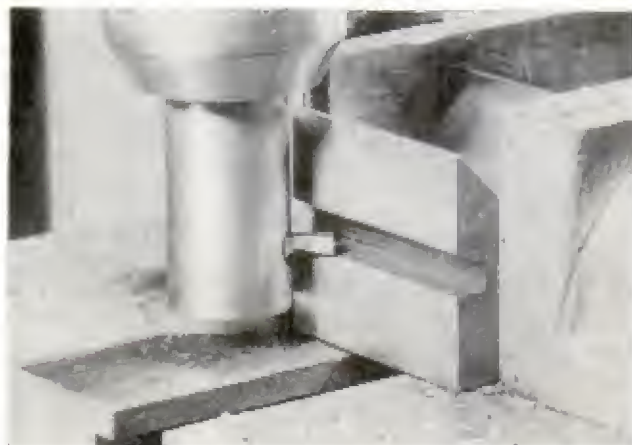
There is considerable difference in the milling qualities of different metals. Even mild steel can vary so much that one piece may be milled at well over 1000 rpm, while 750 rpm may be the maximum for a different piece of the "same" metal.

Alloy steel is very unpredictable in this respect. It's always a good idea first to make a trial cut on the piece of steel selected for a certain job. If it appears it will be difficult to mill, a different—and more easily worked—piece of steel should be substituted. ★ ★ ★

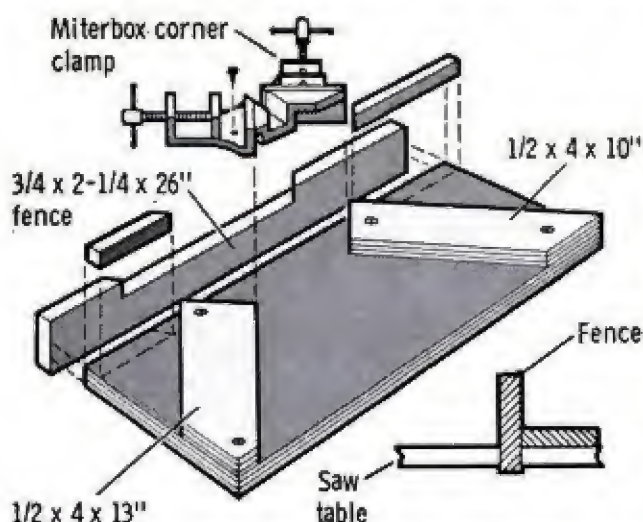
V-BLOCKS ARE EASY TO MILL by making successive $3/32$ -in.-deep cuts, each approximately $1/4$ -in. wide



SLOTS ALSO CAN BE MADE with a number of repeat passes. Start slowly to avoid jamming bit in work



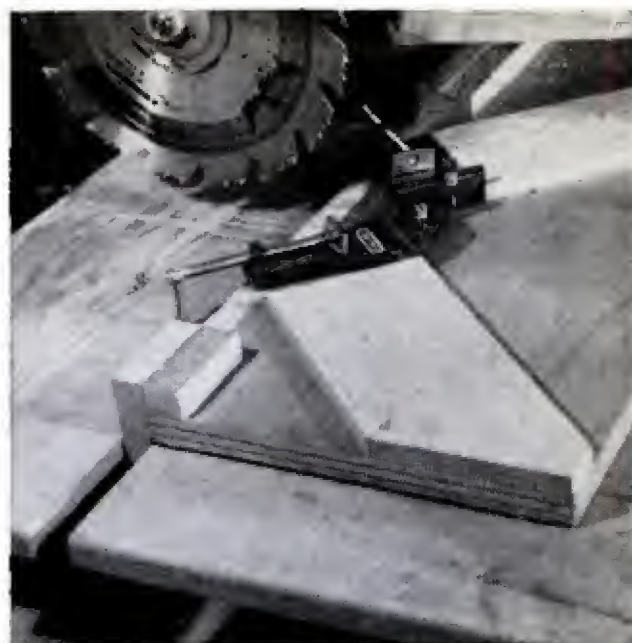
HINTS FROM READERS



Miter jig for radial-arm saw produces perfect fitting joints

Anyone can make a fairly neat miter joint by using a miterbox, backsaw and a bit of wood putty—but with this simple jig for your radial-arm saw, you're assured of perfect miter joints every time. What's more, you'll be able to trim both pieces with just one pass.

The miter jig is built around a Craftsman miterbox (45° angle) corner lamp



which sells for \$2.29. Remove the backsaw guides and the rubber bumper and mount the clamp on a 3/4-in. plywood base with its own auxiliary fence. To use the jig, remove the regular fence from the saw table and lock the jig firmly in place. The two strips of scrap plywood tacked to the base will help position and support the molding or framing being cut.—A. Joyner

Filling cracks in concrete

I had quite a few hairline cracks in the concrete floor of my carport and was advised by "experts" to widen the cracks and fill them flush with cement. Halfway through, I gave up the chipping and filled the rest of the cracks with auto body filler. Now the cement-filled cracks have reappeared, but not those filled with the body compound.—Stephen Stresnic



Cool it in the washer

Every time my children have their friends in for a birthday party, I stack all the bottles of soda in the clothes washer and cover them with ice cubes. Not only does this keep the soda cold, it also saves storage space in the refrigerator for cakes, ice cream and other party favors. When the party's over, just drain out the water in the usual way.—R. Sowa

An ounce of prevention

Those heavy springs that take the work out of raising an overhead garage door can become dangerous missiles if they snap under tension. True, the possibility is rather remote, but to play it *absolutely* safe, make this simple low-cost modification that will keep broken springs from becoming airborne. For a single door, run a wire cable up through the center of the spring, loop it over the pin at top and bring it back down again. Using cable clamps, make loops in the two ends and secure them to the door jamb with heavy lag screws. For a double door with springs (left), use a carriage bolt to join similar loops to ends of the springs.—Clifford Lillo

Turning Rings

On a Lathe

By WALTER E. BURTON

RINGMAKING is an exciting but often overlooked talent of the metal-working lathe. You can turn out sizes and shapes you could never buy—big, little, square, rectangular, triangular, oval, round, half-round, hexagonal, octagonal—you name it. You can make them of steel, cast iron, brass, aluminum, rigid plastic, even hardwood such as maple.

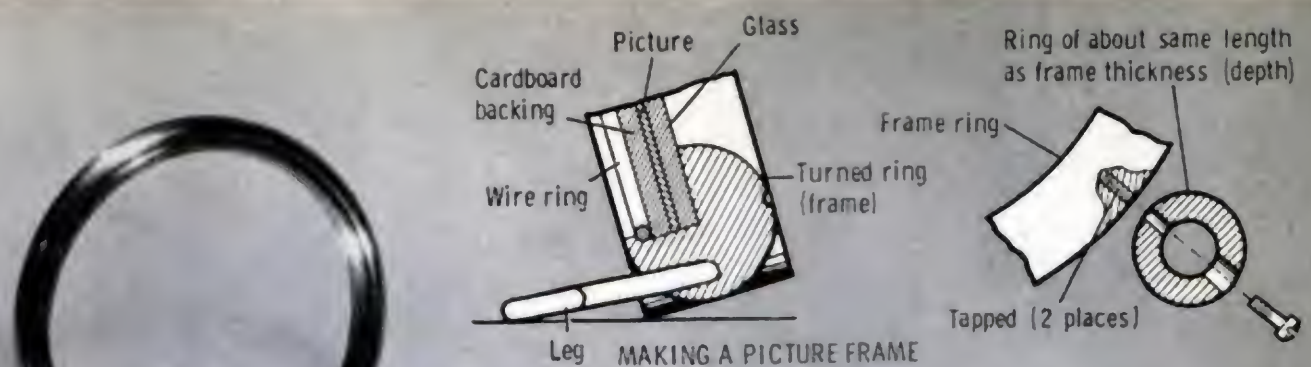
Turned rings are, of course, jointless. They have a handsome, elegant look that makes them ideal for pieces of jewelry and ornamental hardware. They can be used as decorative drawer and cabinet pulls, ladies' brooches and stands for models. Large rings can serve as bracelets or unusual picture frames.

The stock you use for making rings can be hollow tubing or pipe or solid bar material in round, hexagonal or other shapes. If you start with bar stock, you first bore out the center. Plain rings can be made simply by slicing sections off

Ever wonder how you make a ring with no joint? Slicing pipe and tubing like bologna produces perfect seamless circles in many types and sizes

PLASTIC RING, turned from a section of plastic plumbing pipe, gets a polishing below before final cut is made to separate it from remaining stock





SOME OF THE MANY RINGS you can make are shown above. Oval ring to left of center was made by squeezing a round ring with pliers to flatten it slightly. At top is an example of how a large ring

can become a decorative picture frame. A recess is machined at the back to hold the picture and legs are added, as shown in the sketch. Big rings of this type could also make novel ladies' bracelets

RINGS DROP OFF one after another and slide neatly onto this automatic catcher. The simple device consists of a bent wire held in the tailstock chuck



FREEHAND TURNING enables you to shape round, oval and other curved-section rings. Tool is hand-held. Bar clamped in toolpost serves as toolrest

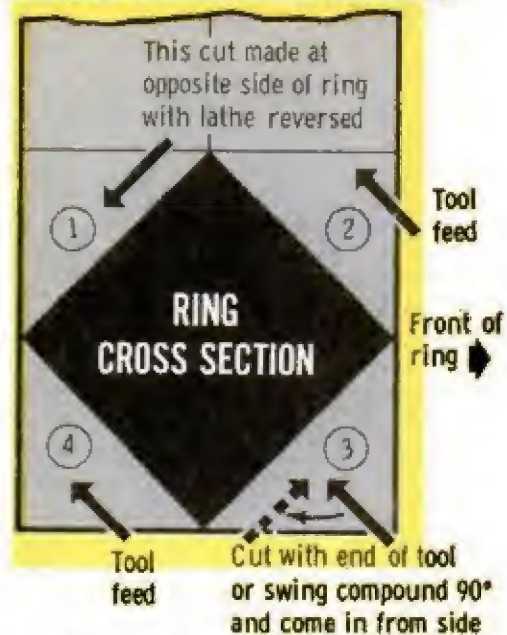


your stock like cutting a loaf of bread. If the width of the slice is the same as the wall thickness of your stock, you have a ring of square cross section. By making cuts at various angles, you end up with a ring of triangular, diamond, hexagonal or octagonal section.

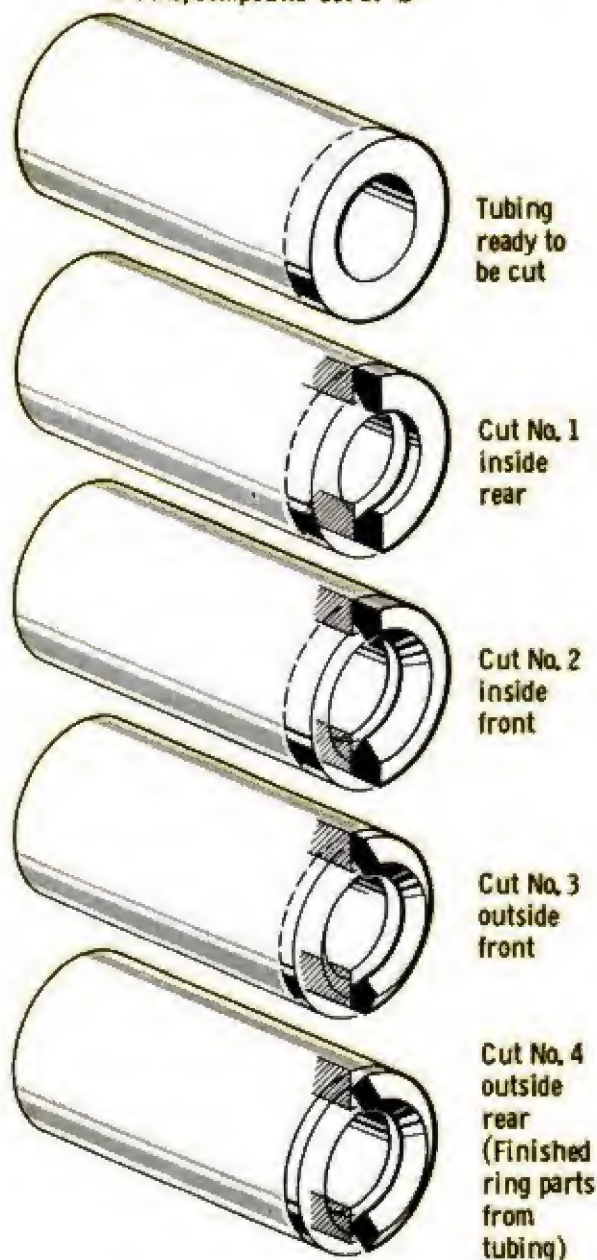
As a matter of safety, it is not a good idea to let the stock project excessively beyond the chuck. The shorter the projection, the better. Chuck jaws can grip a tubular piece on either the outside or inside. Sometimes the outer end of a solid bar can be steadied on a tailstock center if you don't bore away the material at the bar's center until later.

When rings are to be cut from long stock, the piece should be supported near its outer end by a steady rest, as shown in some of the photos. The end toward the headstock should be gripped firmly by the chuck or lashed securely to the faceplate

Turning a Diamond-Shaped Ring



Numbers indicate sequence of cuts, compound set at 45°



HOMEMADE BITS speed the work on special jobs, such as turning out round or oval-section rings in quantity. One below, for round-section rings, was made from old flat file. Two holes of ring diameter were drilled, the material between them removed, relief angles filed, and the tool rehardened. Bit is held in regular boring-bar holder, as above





INSIDE CUT on diamond-shaped ring (cut No. 1) is made at far side of stock with lathe reversed. All other cuts are made at stock's near side with lathe running forward, as shown in diagram



OUTER CORNER of stock can be removed in two ways. You can feed toward headstock, as here, using square end of bit to do forming, or swing compound 90° and feed from opposite direction



INNER LIP of stock is machined by feeding tool with compound-slide screw. Final cut (cut No. 4) has been started here, will be deepened later to part ring from stock as the last step

to prevent endwise crawl from occurring.

Single rings often are clamped in a chuck for minor finishing operations such as filing or sanding for smoothness, rounding sharp edges, or removing the "flash" left by a cut-off tool. The ring should be clamped to run true. Sometimes an independent-jaw chuck is preferable because the ring can be centered accurately with the aid of a gauge.

Remember that when you clamp a ring in a chuck, jaw pressure springs it slightly out of round. Tubular stock is similarly distorted near the chuck. A ring machined from a blank distorted in this way, will not be perfectly circular when jaw pressure is released. In most cases, this is probably not important, but it could affect ring fit in close-tolerance work, such as in making optical-instrument parts.

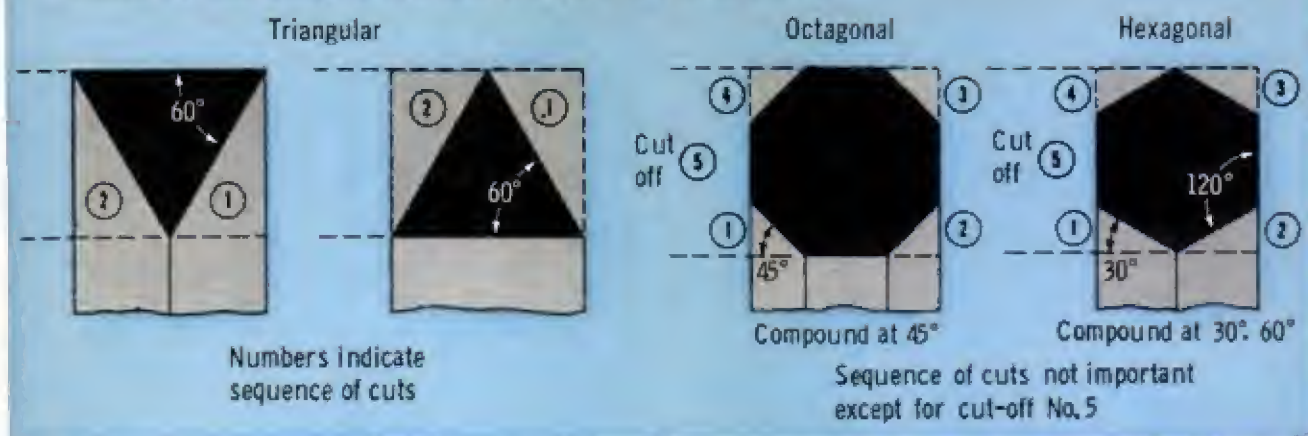
Metal, plastic and wood rings can be shaped freehand on a metal lathe in much the same manner as parts are formed on a wood-turning lathe, the tool being hand-held and supported by a fixed rest.

Carbide-tipped turning chisels are available for use on metal parts, or you can grind suitable ones from tool steel or high-speed-steel lathe bits. Various common wood-turning chisel shapes are useful in working metal rings. The skewer shape is particularly handy. Such tools can be manipulated to cut, rather than scrape, metal neatly from the work, with the formation of fine, thin chips. The hand-turning technique is useful in shaping rings having round, oval, or similar cross section and in making decorative grooves and ridges.

Rings having diamond-shaped, triangular, hexagonal and octagonal sections can be formed by feeding the tool with the compound rest set at the proper angle. Here is a helpful way to work out the machining sequence: Draw a scaled plan of the desired ring cross section, showing it as if you were looking down on top with the side facing you representing the side toward which the tool will feed. With this, you can easily determine the angles, dimensions of various faces, and distances the tool must travel in making different cuts. These values are then used to control the movement of the tool bit by means of the micrometer collars on the carriage screws, particularly that controlling the compound slide.

The drawings show the cross-sectional

Some of the Many Different Shapes You Can Make



layout of rings of various sections. The numbered segments indicate waste material to be machined away. In some cases, the numbers represent a suggested cutting sequence, selected to make it easier to establish starting points for measuring tool movement.

You can make nonmetal rings from such materials as rigid PVC (polyvinyl chloride) pipe available in many stores. Such plastic material is machined much as if it were metal. It is easy to cut and requires only moderate tool pressure. Chuck-jaw pressure should be controlled according to the strength and bendability of the material.

A ring can be machined to serve as a frame for a round picture, plaque or other object. In the back of the frame, ma-

chine a recess to receive the picture, a glass or plastic cover if one is used and a piece of backing material, such as heavy cardboard. The simplest holding arrangement consists of an open ring of wire sprung into a shallow groove around the inside of the recess. Feet for the frame to stand on can be made from smaller rings attached to the main ring with screws, rivets or solder.

You can finish turned rings in the same way as other items of the same materials. Files and abrasive paper or cloth are suitable for smoothing most materials. Rings can be given various distinctive textures by knurling them while they are in the lathe, or by some other suitable treatment such as peening, engraving or stamping. ★★★

NEXT MONTH IN SHOP AND CRAFTS

WHAT YOU SHOULD KNOW ABOUT FIRE WARNING SYSTEMS. There are any number of fire warning systems that you could buy or install, but almost all of them share a common feature—they could save not only your living room furniture, but also the lives of members of your own family. For a complete rundown of these systems, read the February issue of *PM*.

MODEL A 24-POUNDER FROM THE CONSTITUTION. This gleaming replica of a cannon from the U.S. frigate *Constitution* is a wood and brass, 1/20th-scale model that's an ideal project for the winter months. Complete plans and lathe-turning tips will greatly simplify its construction.

HOW TO GET THE MOST FROM A CIRCULAR SAW. This little workhorse can do much more than just cut wood—it will also cut your working time and effort if you know how to use it efficiently. Exactly how you can gain this expertise is covered fully in next month's issue.

FIVE WEEKEND PROJECTS FOR FUN AND FUNCTIONAL USE. Next month's collection of workshop projects will include a toy box that looks like a circus wagon, a handsome glass-topped coffee table, a corner bed table, an Early American cup shelf and a handy holder for an electric knife.

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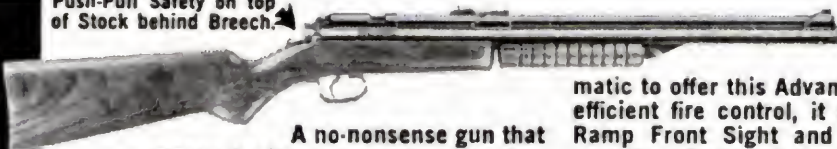
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YOUR SECOND CAR A TRUCK?

(Continued from page 87)

and 133 in. in the CS/CE 30 (one-ton) series. Four-wheel drive is available in the ½-ton and ¾-ton lines. And optional power steering is available on these four-wheel-drive models for the first time.

Good visibility is the advantage of new Below-Eye-Line outside mirrors. Low mirror mounting and elimination of upper support arms do the trick. Seatbacks are now polyurethane foam.

Half-ton and ¾-ton panel trucks, offerings unique to Chevy since the introduction of compact vans for covered cargo space, are still available. And a special "Longhorn" pickup is for campers.

● **Dodge.** Chassis modifications on four-wheel-drive models lower overall height of these "power wagon" pickups. Four-wheel drive is available on all pickups: ½-ton, 100 series (114 and 128-in. wheelbases); ¾-ton, 200 series (128-in. wheelbase) and one-ton, 300 series (133-in. wheelbase). Six-passenger, four-door "crew cabs" are available on ¾ and one-ton models with resulting wheelbases of 146 and 159 in., respectively. Exception is wheelbase on the ¾-ton camper special which is 160-in. The luxurious Adventurer is available in D100 and D200 (two-wheel drive) models only.

A "compact pickup," the A100 on 90-in. wheelbase, a unique Dodge offering, is best described as a van pickup—a van-type cab ahead of an open cargo box. Racing buffs probably know the A100 as the Little Red Wagon, a hemi-charged, hair-raising hot rod.

Powerplant choice is between 170 and 225-cu.-in. slant Sixes, or 318 and 383-cu.-in. V8s. Ride and handling of D100 and D200 models has been improved by the addition of a sway bar to the "cushioned beam" front suspension, lower spring rates and plastic tip liners between leaves.

● **Ford.** More "user packages" to simplify selection of a pickup enhances the '69 lineup. Pickups job-engineered for contractors, farm and ranch folks and those who need the works in the way of heavy-duty outfitting have been added to the "Camper Special" package. Ordering the camper package saves you making a long checklist of necessary equipment, heavy-duty springs, and so on, but equipment can also be ordered *a la carte*.

Half, ¾ and one-ton pickups in the line are designated F-100, F-250 and F-350 with 115 or 131-in., 131-in., and 135 or 159-in. wheelbases, respectively. Four-wheel drive is available on 100 and 250 pickups and engine offerings are 240 and 300-cu.-in. Sixes and 360 and 390-cu.-in. V8s.

Standard front suspension on all two-wheel-drive pickups is the four-year-old Twin-I-Beam, a proven design in no need of updating. Standard on the F-250, but optional on the F-100, is the Flex-O-Matic rear suspension, a design that shortens the leaf spring's effective length with increasing load, yet allows a long, more flexible spring for a cushioned ride when the pickup is unloaded.

● **GMC.** Ditto everything said about the Chevrolet lineup, above, for the GMC line. Half, ¾ and one-ton pickups, designated C-1500, C-2500 and C-3500, are essentially the same as their Chevy counterparts. Among few differences is an additional engine, a 305-cu.-in. V6.

The luxury-loaded GMC models are romantically branded Sierra and Sierra Grande, and the GMC equivalent of the Chevy Longhorn is the Custom Camper.

● **International.** At this writing, the International Harvester Co. is readying its new line of pickups for introduction during December. Exterior design of the 24 models is all new, as are several other features. A 232-cu.-in., 145-hp Six, new standard engine for the line, promises greater fuel mileage than the previous, similarly powered Six. Optional V8s displace 304, 345 and 392 cu. in. Gears in a new three-speed transmission can be shifted manually ("His . . .") or not shifted by leaving the lever in automatic (and Hers"). Five-speed forward transmission with or without overdrive is still available.

Several wheelbases are available in the half-ton (1000 series), ¾-ton (1100 series) and one-ton (1200 series): Along with the 115 and 119-in. wheelbases, a 131-in. has been added to the 1000s. Same three wheelbases are available in the 1100s, with a fourth, 149-in., in the 1200s. Crew cabs (149 and 164-in. wheelbases) can be ordered in the 1200 line. And four-wheel drive is optional on 1100 and 1200. I-beam front axle is standard on heavier pickups; independent torsion bar is standard, I-beam optional, on ½-ton units.

● **Jeep.** Kaiser Jeep Corp. continues unchanged its line of ubiquitous Gladiator pickups, all with four-wheel drive as standard. A special camper pickup of unique design is about to be introduced and will be on the road for the 1969 season.

The J-2000 and J-3000 series have 120 and 126-in. wheelbases, respectively, with GVWs from 5000 to 7000 pounds. Six-cylinder, 232-cu.-in. engine is standard, 327 V8 is optional.

The four-wheel-drive Jeep line, however masculine, offers a full range of comfort and luxury items, and is the only brand to offer four-wheel drive paired with an automatic transmission. ★★

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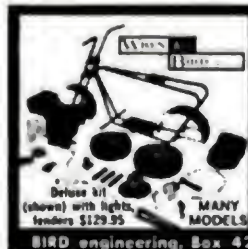
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HOW CARS ARE STYLED

(Continued from page 91)

new engine, drive train and body/sub-frame construction were tested on public roads for hundreds of thousands of miles, even before the car's final body shape became jelled.

Then, too, body dies have to be made. These begin immediately after the car's styling is set. Specialists start carving so-called "die models" from solid mahogany or carvable epoxy plastic. These die models have to be compulsively exact, because special machines feel and translate the finished die model surfaces into metal dies. Later, the metal dies are assembled in gigantic stamping presses, then accurately aligned.

This description necessarily skips hundreds of the steps involved, simply because of their number.

1600 people shape GM styling

As mentioned, all four carmakers go through more or less the same processes in styling their new models. General Motors, with the greatest number of models, employs more designers than any other company in the world. GM estimates a total of 1600 people are involved directly in their styling processes.

GM's Central Styling Studio serves the various auto divisions, plus Chevrolet and GMC trucks. It regards the divisions as clients. Yet within Central Styling, each division is assigned a number of designers who work only on that make.

Pontiac, for instance, has four designers, an assistant chief designer, and a chief designer. Those six men hold responsibility for all Pontiac car exteriors (with Styling-Management direction, of course). Same with Chevy, Olds, Buick and Cadillac.

Several separate studios

Then there's GM's Body Development Studio. This group bridges the gaps between divisions so several can share the same body shell. It's common knowledge that big Chevys and Pontiacs share one basic body. So do the GM intermediates; the big Buick, Olds and Cad; and Riviera, Toronado and Eldorado.

General Motors also maintains separate studios for Interior Styling, for Advance Design, for Styling Research. Advance Design might be working on those 10 to 15-year-ahead concepts, while Styling Research dabbles in new body architecture, methods and processes of future types of transportation.

Over at Ford, the picture looks much

(Please turn to page 198)

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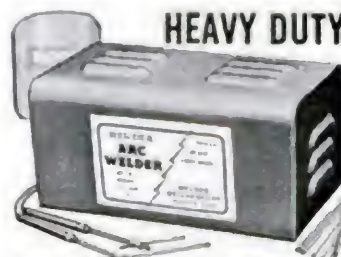
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HOW CARS ARE STYLED

(Continued from page 196)

the same on a slightly smaller scale. All FoMoCo cars, trucks, and tractors get styled in the new 493,000-square-foot Design Center at Dearborn. Here, five major design offices, complete with fabricating shops, engineering layout rooms, indoor and outdoor showrooms, house individual studios for Ford Div. (Ford, Fairlane, Falcon, Mustang, Thunderbird and Ford trucks), Lincoln Mercury (Continental, Lincoln, Mercury, Monterey and Cougar), Interiors, Corporate Projects and Special Development.

Divisions share body shells

This is a slightly different setup from GM, because the two big FoMoCo divisions work with a bit more independence. Yet again there's overlap and coordination in shared body shells—Mustang and Cougar, Ford and Mercury, Montego and Falcon/Fairlane.

To give some idea of Ford's styling activities, the corporation buys roughly 150 tons of clay each year. And this isn't the river-bottom variety. It's a closely guarded formula with high contents of sulphur, iron oxide and other chemicals.

Chrysler Corp.'s setup is much like Ford's, with relatively great independence between divisions.

American Motors, being the smallest Big Four automaker, has the smallest styling staff. AMC has a Senior Studio, responsible for Ambassador and Rebel; a Junior Studio for Javelin, AMX and American; an Interior Soft Trim Studio; Interior Hard Trim Studio; and an Advance Styling Studio where the far-out designs originate.

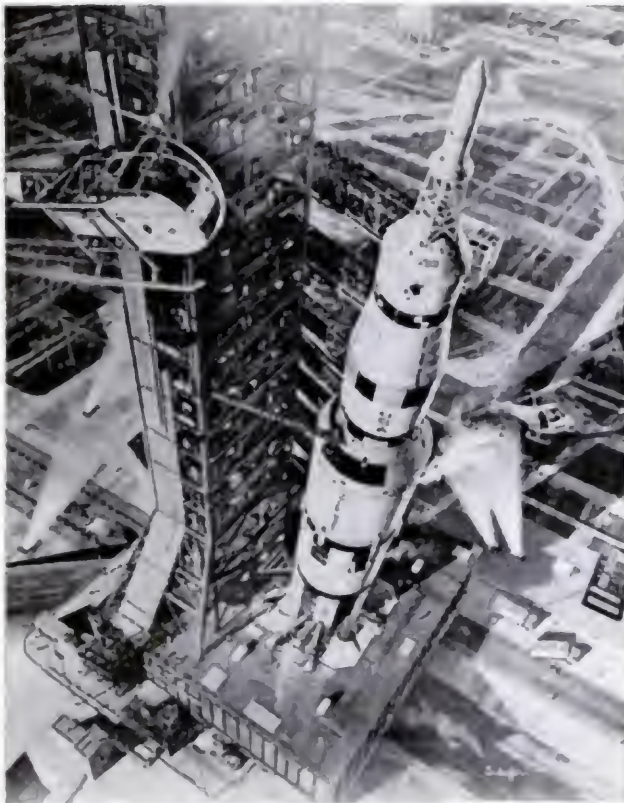
Major sales factor

The business of automotive styling—or art form, whichever it is—isn't even two generations old, yet it's already one of the most important facts of our nation's economic life. A new car's styling is its strongest single selling point. More people buy a new car on the basis of exterior and interior appearances than any other attribute. Price, engineering qualities, brand loyalty and other factors influence buying decisions, naturally, but none sways the customer so compellingly as styling.

And since the auto industry ranks so high in our nation's economy, provides one out of every seven jobs in the country, and acts as the bellwether of our economy, it's safe to say that styling—in helping sell so many new cars each year—constitutes much more than a vanity. It's a vital necessity. ★ ★ ★

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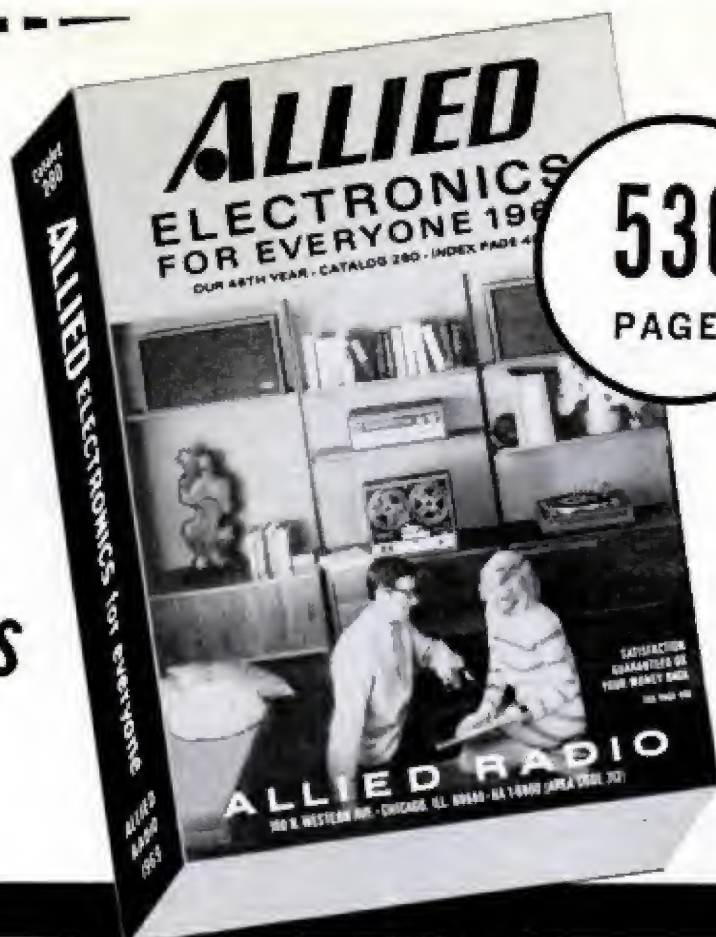
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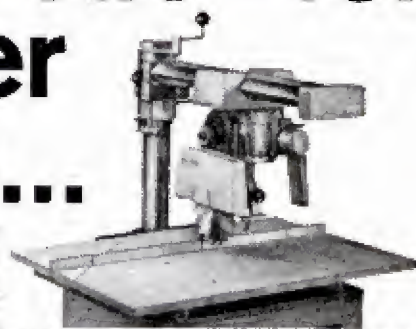
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FLYING THE ENGLISH CHANNEL

(Continued from page 105)

past one of the regular cross-channel car ferries and swooped under the stern of a Brazilian cargo ship, whose astonished crew lined the rail to watch a vessel twice as fast as any they'd seen before. Once we bore down on a trio of seagulls drifting complacently in the swell. They hadn't been warned about Hovercraft, either, and they passed right under our floating hull. Yet such is the even pressure of the air blast—only 60 pounds per square foot—that they emerged at the stern surprised but only ruffled. I asked if I was allowed on deck. "Not unless you enjoy standing in a 50-knot gale," said the steward.

I had a slap-up French lunch in Boulogne. When I returned to Dover in the evening, the wind had whipped up six-foot waves, and our speed was cut down to 40. There was no sideways roll at all, but a good deal of pitching, with occasional and unexpected swoops down into the troughs. There was more seasickness than there would have been in a conventional ship, yet, on arrival, one ashen-faced woman victim told me: "I'm always sick anyway—and I'd rather it was half an hour instead of two."

Noise just a buzz

I had expected to be half deafened by the noise, a big Hovercraft bugbear in the past, both for the travelers and for the residents of the ports. The problem is the great speed of the propeller tips, which in previous craft had reached Mach 0.8, or some 600 mph. By making the N4's props a full 19 feet in diameter, the tip speed is kept to Mach 0.6; the noise is less than that of propeller aircraft. Inside the cabin, you soon get used to the steady buzz that comes through the thick roof insulation. The cabin crew don't notice it now—"although it gave me a sore throat the first day," one steward admitted.

"You know, you couldn't sink this thing if you tried," he told me later, after we'd passed lightly over a huge floating tree trunk. "There's 24 separate sealed buoyancy tanks in the deck. You could split her from stem to stern, and she'd still float." In fact, with a reserve buoyancy of 250 percent, 10 of the 24 tanks would keep the whole craft up. You can't see any of the guts of an N4: Round the base is the massive eight-foot rubber-and-neoprene skirt that contains the air blast and keeps the craft riding high. The lower half of the skirt looks like a row of giant licorice sticks; these are the "fingers" which, being separately replaceable, greatly reduce the cost of skirt maintenance; and,

being separately movable, reduce the expensive losses of air.

For a short while, I visited the control cabin of *Princess Margaret*. You reach it by a steep ladder leading up from the car deck. It looks much like the flight deck of a medium-sized airliner—except that it lacks an artificial horizon. The real horizon, topped by the glaring white of Dover's chalk cliffs, bucks disconcertingly as the craft jerks over the waves. All the crew wear headsets. The pilot sits at banks of gleaming dials that indicate airspeed and waterspeed, propeller pitch and rate of turn. He steers with his feet on a rudder bar that turns the propeller pylons and the two stern-mounted rudders. To his right is the engineer first officer, who shares the driving. At "takeoff" and "landing," one of them looks after the steering while the other controls lift and thrust.

Short stopping distance

Behind them sits the navigator, armed with Decca radar. Traveling at 70 knots across a waterway used by nearly 1000 ships a day, he has a normal stopping distance of half a mile, or 100 yards in emergency; and foreign mariners have not yet learned to allow for a crossing craft going five times their own speed.

At present, the N4 service is more expensive than a conventional steam ferry: a small car with two passengers, one way across the Channel by Hovercraft, costs about \$19—a third more than by steamer. But charges will probably come down as the service becomes better known, and the traveler in a hurry will always value a saving of an hour and a half on the sea, followed by a quick five minutes from car deck to customs.

All the crew are immensely proud of their craft and of its amazingly quick 25-minute terminal turnaround. A smart, bearded fellow in a tweed jacket next to me turned out to be John Syring, one of the regular pilots on the route. This was his day off, and he was spending it at his favorite place: aboard *Princess Margaret*.

"Fastest ship in the air," I commented.

"Yes," he replied. "Or, fastest plane on the sea."

★ ★ ★

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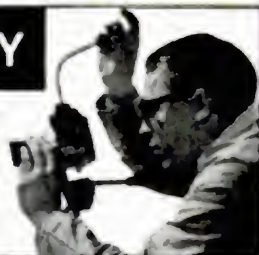
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SMALL SPORTY SEDANS

(Continued from page 108)

most appealing feature. With sophisticated independent springing front and rear, the BMW can negotiate the roughest roads without a trace of axle hop. Cornering is safe, predictable and faster than that of most all-out two-seater sports cars.

Ride is nothing short of sensational over all surfaces and at all speeds. Our test car leaned sharply on corners, but we had an early model that lacked front and rear sway bars. Later models should corner flatter, even faster.

The overhead-camshaft Four is a masterpiece of precision engineering. It starts immediately in all kinds of weather with little or no choke, runs smoothly and quietly, cranks out 0 to 60 in 10.1 seconds—fastest time of any of the five test cars. Those 114 horses are good for a top of 106 mph, matched only by Fiat.

Transmission is light, quiet, precise and beautifully synchronized. Steering is sensitive and light, with good road feel.

What's *wrong* with the BMW? Well, the steering wheel is too big and too high—and the brakes (discs front, drums rear) fade noticeably. After several consecutive panic stops from 60, pedal pressure increased markedly, along with stopping distance (longest in our tests). The brakes aren't really bad, but we expected better in such a high-performance machine.

FIAT 124 SPORT COUPE

The neatest styling package, in our opinion, is the Fiat. With crisp, modern lines, Ferrari-like grille, huge greenhouse (visibility at least as good as the BMW's) and bobbed tail, the Fiat got more attention than any other car we drove.

At \$2878, it's in the BMW's price range—a choice between them is tough. Though labeled a coupe, the Fiat has a cabin as roomy as those of our other test cars—which is why it's included here.

If the driving position in the BMW is excellent, in the Fiat it's superlative. Beautifully shaped bucket seats offer comfort, lateral support and a wide range of adjustment. The small, sporty steering wheel allows a straight-arm grip, and all controls are perfectly located.

With the front seat all the way back, rear legroom is zero, but even the tallest driver isn't likely to need all the available adjustment. The heavily upholstered rear seat is comfortable for two.

The interior is tasteful and luxurious, with full carpeting, a wood grain instrument panel that looks like the real thing, and a full complement of legible gauges, including a tachometer. Quality is out-

standing, except for an abominable harness-belt combination that rides well above its victim's beltline. The trunk is a shade larger than the BMW's, but a small load opening limits its usefulness.

The Fiat is living proof that an independent rear suspension isn't the only route to go for top handling and comfort. With its well-located live rear axle, the car can take any corner, smooth or rough, at astonishing speeds. The ride is tight, well-controlled and absolutely flat.

The BMW and Fiat go around corners extremely fast, but differently. The BMW steering feels neutral until near the point at which the tires lose their grip. Then oversteer gradually sets in; rear tires slip wider and wider until finally, after three airmail letters and a telegram to tell you what's happening, they let go. A skillful driver can use such oversteer to hang out the tail end, dirt-track style, to increase cornering speed.

The Fiat understeers all the way; the front tires slip wider and wider as cornering forces increase. If pushed beyond reason, the Fiat eventually plows straight ahead instead of following the curve of the road. But, still, we think such understeer feels more stable and imparts more confidence to the average driver.

A big plus for the Fiat is four-wheel disc brakes. They snub the car down straight and fast, with no hint of fade.

Like the BMW, the Fiat has some exquisite machinery under its front-hinged hood: a dual-overhead-camshaft Four cranking out 96 hp from 87.75 cu. in. It only starts to perform above 3500 rpm, but this is no problem if you don't mind rowing that light, precise, extra-fast shift lever to keep the revs up.

In acceleration, the Fiat was second to BMW with 11.5 seconds from 0 to 60. And the sound of that exhaust! Only the Italians could shape such a beautiful note.

SAAB DE LUXE

Most unorthodox of our test cars was the Saab De Luxe, which sells for \$2550. The De Luxe label entitles you to Pirelli radial-ply tires and a tachometer.

Before testing, we wondered whether the Saab could fairly be included in such sporting company. Our misgivings proved valid in performance: The 73-hp, 91.4-cu.-in. V4 took 15.2 seconds to reach 60. Top speed was an unglamorous 95. Nevertheless, the car has many attributes that the knowledgeable driver should like.

Unfortunately, styling isn't one of them. Originally a sleek, functional wind-tunnel design, the car has suffered at the hands of stylists. A few bulges and scoops added

(Please turn to page 208)

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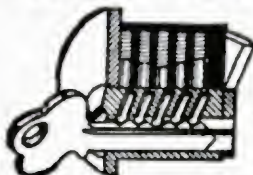
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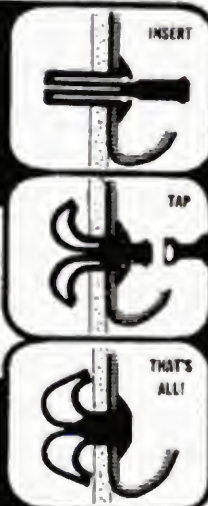
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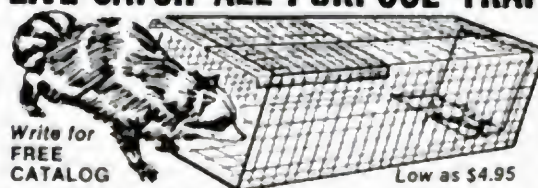
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SMALL SPORTY SEDANS

(Continued from page 206)

here, a little overhang there, extra bright-work all around, and the result is best described as neo-Zeppelin.

The car is rugged. The few Saabs that have rolled over in competition invariably came through with roof and pillars intact. Panels and trim are perfectly aligned.

The interior is neat, though a bit old-fashioned and plain-Jane. There's a big, legible speedometer and tachometer, a small clock and a fuel gauge. All other functions are monitored by warning lights.

Front seats, with vinyl-trimmed cloth, adjust to fit any size driver and passenger. The rear seat holds two comfortably, three in a pinch. An optional kit, which takes about 15 minutes to assemble, converts the seats into a double bed.

The sharply slanting windshield comes uncomfortably close to the driver's forehead. We kept bumping our heads on the rear-view mirror when climbing out.

The trunk, displacing a roomy 13 cu. ft., looks like a tunnel. Unhappily, the tiny, stiff trunk-release knob—it's fiendishly blocked by the bumper overrider—offers a constant test of strength. However, it's easy to forgive such minor flaws once you drive the car. Countless wins in major European rallies attest to its cornering. With front-wheel drive, it is especially stable on icy, snowy roads. Perhaps that's why Saab is so successful in New England.

Like other front-wheel drives, the Saab tends to understeer with power on. But let up on the gas in a corner and you get a dramatic change to oversteer. A novice may find this scary, but once you get the knack, it's great fun. You actually can steer with the throttle. Ride is fairly good on normal roads, but is harsh on rough surfaces unless you drive fast.

The little V4 starts willingly, idles smoothly, and revs past its 5600 rpm red-line without protest. Our self-imposed 6000 rpm limit felt conservative.

An odd feature is the freewheeling device that automatically disengages the engine from the transmission and allows it to drop to idle speed whenever you lift off the throttle. With the old Saab two-cycle engine, freewheeling kept the engine from starving for oil on the overrun. On the V4 it cuts down on air pollution, eliminating the need for an air pump. Also, it saves fuel. And in a skid, a freewheeling car is easier to control.

Unfortunately, when you want to accelerate again, it's hard to feed just enough gas to avoid an unpleasant jerk. And we missed the absence of engine braking.

The four-speed transmission is beauti-

fully synchronized, but a sloppy, balky column linkage takes all the fun out of shifting. Steering is very fast and precise, but heavy. The brakes (discs front, drums rear) take repeated panic stops with little fade. Stopping distances compare to the Fiat's, but directional stability isn't as good.

The Saab's best selling point probably is its reputation for reliability. The new V4 shows every indication of matching the old two-cycle's ruggedness.

CORTINA GT

If you prefer Detroit styling, you'll be at home with the Cortina. It looks like an un-Sanforized Falcon that got caught in the rain. The GT interior shows a strong American influence, with a stylized instrument panel and floor-mounted console with storage bin and built-in clock.

Exterior workmanship on our test car was reasonably good, but things could have been improved inside. Cutouts in the carpeting were oversize. There were a couple of glue drippings on the upholstery, and the headliner suffered from a few odd-looking lumps.

Also, there are what we feel are designed-in boo-boos. Rear windows are sealed shut. Instead of a folding seat back, the entire front seat hinges forward for rear access. This is inconvenient and the seat also knocks the rear-view mirror out of kilter. (So do the sun visors.) The brake pedal is too close to the transmission hump and tends to snag your shoe when you lift off the accelerator.

Front buckets are attractive and comfortable. With the console, they give good lateral support. Front legroom is a bit snug, but rear legroom was the best of all our test cars. Front-seat brackets can be reversed to increase travel.

The Cortina GT is unusually well instrumented, with large, round speedometer and tachometer, and legible gauges for amps., fuel, coolant and oil. The recessed package tray actually holds small packages without obstructing vision.

The engine, a 97.5-cu.-in., 93-hp Four, boasts several unusual features. A cross-flow head allows gases to enter and exit without turning corners, increasing engine efficiency. Combustion chambers formed in the pistons instead of the head, means that chambers can be cast absolutely identical, making for a smoother engine.

Our 0-to-60 runs averaged a respectable 12.2 seconds, in spite of the high first gear. Top speed is about 96.

The beautifully synchronized transmission takes the most brutal speed shifts without complaint. Our test car, a '68, had a rather vague shift linkage, but the '69s,

(Please turn to page 214)

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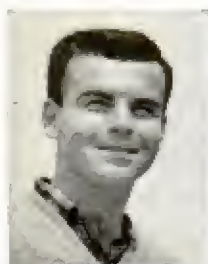
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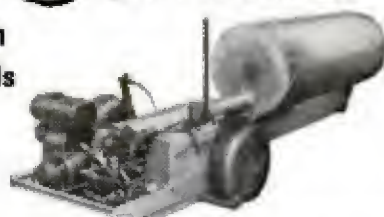
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SMALL SPORTY SEDANS

(Continued from page 208)

unchanged but for safety provisions, are said to offer a more positive linkage.

Suspension feels much softer than that of our other cars (again the Detroit influence). But if the GT's cornering isn't terribly fast, at least it's predictable—it understeers at all times. The live rear axle can take fairly rough corners without losing its composure. Brakes (discs front, drums rear) are about on a par with those of the BMW—okay, but nothing to brag about at the local pub.

DATSUN PL 510

The "cheapie" in our lineup, the \$1999 Datsun PL 510, actually offers many luxury features. The single-overhead-cam-shaft Four and independent rear suspension are suspiciously similar to BMW's. But, though the Datsun handles predictably in all situations (it understeers), it can't match the superb cornering and ride of the BMW. Of course, don't forget it's \$1000 cheaper.

Maybe some adjustments in the shock settings or spring rates are the answer. Radial-ply tires definitely would help; the Datsun is the only one among our test cars not to include radials as standard.

The 97.3-cu.-in. engine, producing about 96 hp, takes 14.3 seconds to reach 60. Top speed is 98.

Considering the price range, the manufacturer has to scrimp a little—front seats are small and skimpily padded, offer little lateral support. Front legroom is, we think, inadequate. There are no armrests, no cigar lighter. One key services ignition, door and trunk locks. The handbrake is hard to reach in an emergency. And, personally, we don't dig rectangular gauges.

Yet, the Datsun has many exclusives. It's the only four-door in our lineup. (At this writing, Datsun has just announced a two-door version—for \$133 less!) Rear windows roll down all the way (the other cars, except for Cortina, have hinged rear windows). A radiator fan cutout is standard, as are whitewalls and dual headlights. The built-in ventilating system is most efficient. And the disc-drum braking system consistently chalked up the shortest stopping distances, with no deviation.

What's more, Datsun alone offers an optional automatic transmission (\$165).

From a practical standpoint, the Datsun may offer the most value for the money. For dependability, we vote Saab. Cortina GT gets the nod for comfortable motoring on a budget. But if you want to go hunting at a price for wild beasts from Detroit, you can't beat BMW or Fiat. ★★

OFFICE UNDER THE SEA

(Continued from page 117)

ordinary working day at the Lockheed Ocean Laboratory. When the boat is in its hangar, the atmosphere resembles a Navy base.

On the bulletin board in the hangar, schedules give times by military system, on the 24-hour clock. Operational orders, too, are strictly GI. They start off "To: All Hands."

In the bookcase in Don Saner's office you'll find a well-read copy of the *Boatswain's Mate* handbook as well as old Navy manuals. Fur-collared Navy flight jackets are also popular among civilian submariners, who insist the "USN" inside stands for "University of Southern Nevada."

Service atmosphere

There are admittedly times when the men themselves seem to forget they aren't back with the Fleet. Bob Worthington told this story. It happened aboard the *Transquest* as it was carrying the *Deep Quest* out for a dive.

There for the event was a Lockheed engineer who ordinarily worked in the company's home plant up in Sunnyvale, Calif. He was busy aft with some equipment when the ship's chef got Dave McCafferty out of hearing. "Say, skipper," he asked in a whisper, "who's that civilian aboard?"

If Lockheed's little San Diego naval base is a lot like a corner of some Navy yard, being at sea with the support ship and sub is, to many of the men, all the world like being back in service.

Pilot of the *Deep Quest* during dives sits in the left-hand seat in the forward sphere. Before him are instruments and controls that are a combination of those found in ships and planes. The fathometer is no different from that used on a large ship; the magnetic directional compass is, however, taken from an airplane. But the integrated control-and-display system was designed specially for *Deep Quest*.

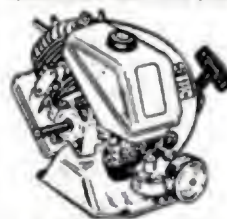
Two handles, something like those used on a helicopter, provide the pilot with control of his two main 7½-hp a.c. motors; two similar motors are installed for vertical movement and water jet thrusters for lateral moves.

The copilot and navigator occupies the right-hand seat. Behind the two in the after sphere ride the two observers or technicians, usually Don and another observer.

Don admits he thought all his seagoing
(Please turn to page 216)

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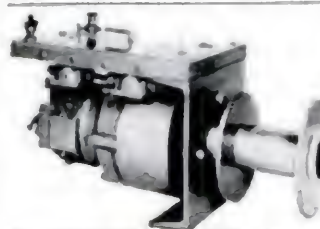
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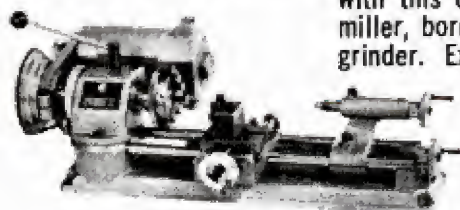
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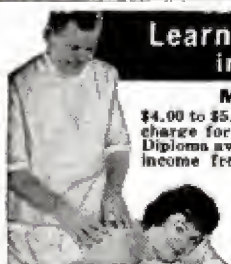
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OFFICE UNDER THE SEA

(Continued from page 215)

adventures were well behind him when he left the Navy. After all, it's tough to top 10 wartime submarine patrols in the Pacific (including six in which contact was made with enemy shipping). Then, too, after the war he served four years aboard the presidential yacht *Williamsburg* before going on to join the nuclear-powered *Polaris* sub *Theodore Roosevelt*. He finally closed out his career as engineering officer and qualified pilot on the bathyscaph *Trieste II*.

"When I retired, I figured I had about three job choices," says Don, ruefully. "I could work as a night watchman, sell insurance or drive a Good Humor truck." Yet less than a year after he walked away from his last day in the Navy, Don Saner was aboard *Deep Quest* 93 miles southwest of San Diego. Its mission: Go deeper than any other true sub had ever been.

Deep Quest had already been down to 6300 feet. Bugs in the design and in some parts had shown up and had been corrected. Now it was time to push the sub down to its design depths, to a level where pressure on those two seven-foot cockpit circles would be 3750 pounds per square inch, more than 230 times sea-level pressure.

Through the forward viewing port, the crew watched the strange marine life bathed in the eerie glow of the high-intensity mercury-vapor flood lights. "I'd been underwater countless times in a Navy sub," recalls Don, "but had never really thought about life outside the boat."

One of Don's jobs on the record dive was to monitor strain gauges. The inner pressure hull was about 90/100ths of an inch thick yet it easily withstood pressures of 3750 pounds per square inch. The sub was down for nearly eight hours.

The compartment grew cold, but no one paid any attention. There was a heater aboard but no one thought to turn it on. "We were just too excited to think about anything but how deep we were going," says Don. "It's not every day that you dive a mile and a half," he smiles.

Deep Quest was in hydrophone contact with *Transquest* on the surface but the orders were to keep all talk to a minimum. Even inside the sub, there was almost no idle conversation.

Watching the strange sea life, Don recalls, "made it all worth while." Then the sub dove deeper, well beyond light, past areas that support vegetation, and finally into the regions where the crew became explorers.

At one point, they snapped the first

photos ever made of a long-finned cod, considered a biological rarity that lives on the ocean bottom. And until *Deep Quest* spotted it, scientists had never known it to go deeper than 6000 feet.

"Guess we extended the known depth of the fish by nearly half a mile," Don says casually.

That dive was made last year. And *Deep Quest* was now in her land hangar being readied to return to her strange and still-unexplored realm.

No nine-to-five job

Regular hours at the Ocean Lab hardly exist. Occasionally, some of the men do knock off on schedule at 4:45 p.m. But that's rare; more often, it's 6:00 or 6:30. And sometimes it's midnight before the men finish their day.

Once the lab is locked up, Don drives home to his comfortable bungalow in the San Diego suburb of Clairmont. He likes to fire up some charcoal in the back-yard barbecue pit and grill some steaks for his family. Son Gary, 17, is a senior in high school this fall; daughter Donna, 21, works in town but lives at home. Don's wife, Joyce, is from Australia. The couple met when Don's submarine was based in Perth during the war.

On weekends, the whole family likes to go out of town to picnic. On occasional free evenings, they might also go bowling together. Bowling, picnicking or tinkering in his little shop are the only parts of Don's life that are typically suburban. His neighbors, however, are hardly aware that Don is a professional submariner. In fact, when he has to list his occupation on a form of any sort, Don casually writes in "research engineer." Saying he's a "submarine pilot" sounds like he's bragging and this would be quite out of character for the quiet Mr. Saner even though his office is, indeed, under the sea. ★★

Hot moon or cold?

Three observers from the Air Force Cambridge (Mass.) Research Laboratories have new evidence in favor of the theory that the moon has a hot interior like Earth's.

Drs. Graham R. Hunt, John W. Salisbury and Robert K. Vincent made the discovery while studying warm spots on the surface of the moon. The spots become quite prominent during eclipses as the moon's surface cools when the Earth's shadow cuts off its sunlight.

The explanation for most of these hot spots is that they represent surface features that cool more slowly than their surroundings.

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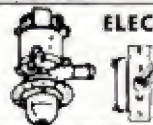
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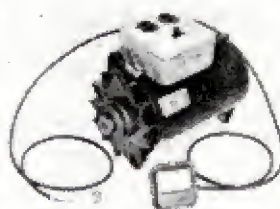
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WONDERFUL BROTHERS WOOD

(Continued from page 121)

into the palm of his hand. When Leonard and Edwards slap the new rubber in place, Clay and Delano reach down and thread on the new lugs. Back into action go the impact wrenches as Clay slips around to give Martin a hand with the refueling and Delano steps back to man the jack.

Glen, in the meantime, has given the entire right side a fast once-over for race damage—pranged sheet metal, rubbing tires, whatever. He then ducks in front, yanks out the hood locking pins, opens the hood, checks for loose wires, hoses, spewed oil, and so on, adds oil if necessary, slams the hood shut, replaces the locking pins. He then scans the left side, checks the left side rubber. If it needs replacing, he grabs another impact wrench and dives at the lugs. If not, he wipes the windshield, confers with the driver.

Kendrick or whoever, having helped Martin with the fuel can, reaches over the wall and hands the driver a drink of water. If the driver requests it, Kendrick also hands him a pressurized water hose with which he can soak himself to cool off. (Should Glen decide the left rubber needs replacing, Kendrick will man another jack from a position inside the pit wall; he'll crank up as the opposite side is cranked down.)

The right side rubber in place and ready to go, Leonard and Edwards step back as Delano dumps the car level and jerks the jack back out of the way. Martin whirls, heaves the can to the ground, twists the fuel cap on. Glen nods, Martin pounds on the roof with his fist to signal the driver the stop is completed, and the car roars back into action.

The entire process has taken about 20 seconds!

Impossible takes a bit longer

Such incredible pit times are possible, of course, only if everything goes smoothly and the car doesn't require special attention. If it does—like the impossible—it takes longer. But not much.

Early in last year's Daytona 500, when Cale Yarborough's '68 Mercury experienced ignition trouble, Leonard leaped in the car during a pit stop and replaced the floor-mounted transistorized unit in such a short time that Yarborough lost only one lap. He was able later to make up the lap and win the race.

"Leonard crawled right over me," Yarborough says, recalling the incident. "Seems he was done and out of there before I could even get focused on what he was doing. Back out on the track, with

everything going right, I was thankful for the Wood brothers. I can promise you."

Another driver who has had occasion to be thankful the brothers are what they are is Dan Gurney. During a pit stop at the Daytona 500 in 1964, Glen cross-threaded a lug nut, stripping the threads. It's a common pit goof, one that is often ignored. But not by Glen—no car and driver in his charge is going to be out on any track with only four lugs holding a wheel in place! He told Dan what had happened and advised that time be taken to make proper repairs. Dan, who had been running with the leaders, was disappointed, but very much impressed by Glen's concern for his safety. The repairs were made and Dan went back out to finish 14th.

"It was a tough break," Dan says, "but there's still no one with whom I'd rather go racing."

Made Indy history

The Woods have been racing as a crew since 1960. They hit international headlines via their astonishing performance during the 1965 Indianapolis 500. They pitted winner Jimmy Clark in 19.8 and 24.7 seconds respectively, the shortest total pit time in the race's history. They've won many pit-crew speed and accuracy competitions, but they often do even better during an actual race.

In what has become almost a cliché of successful pit crews, Glen says, "We don't do anything different than anybody else, we just work at it."

Glen himself has been working at racing since he and a few friends bought a modified stock car almost 20 years ago. He was the driver and the original thought behind the venture was to have a little fun. But the "fun" concept got shoved aside as Glen began to win more and more races.

"Glen Wood was one of the best drivers on an asphalt track I ever saw," says all-time racing great Curtis Turner. "He could read that stuff like the palm of his hand."

As Glen's driving improved and his reputation as a winner grew, he moved up into Grand National cars, the major league of stock-car racing. His driving credits include four Grand National victories, the last in 1963. He retired as a driver in 1964. As he puts it frankly, "Those big superspeedways just weren't for me."

That the transition from pilot to crew chief was smooth and rewarding is attested to by the scores of both driver and "top wrench" trophies lining the walls of his den at home in Stuart. More importantly, it is attested to by the generally

(Please turn to page 220)



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WONDERFUL BROTHERS WOOD

(Continued from page 218)

good-natured envy expressed now and then by his racing peers.

On the morning of qualifying day for last September's Old Dominion 500 at the Martinsville (Va.) Speedway, the Woods were a few minutes behind schedule in arriving at the track.

"Where's Glen Wood?" someone wanted to know.

"Home," a voice answered.

"Humph!" the seeker said, kicking at a pebble. "Probably countin' all that money."

Glen is justifiably proud of his career to date, a pride shared by everyone else involved in the enterprise.

'Pride' is the key

The word "pride," in fact, may be the significant clue to the Woods' fabulous success. All of them—the brothers, the family and friends on the crew, the wives and children, even the one Wood sister (named Crystal)—devote themselves in one way or another to an ideal of perfection. The result is a quiet group self-confidence, a knowledge that because they're serious about, and dedicated to, what they do, they have no need to crank out press releases and talk beyond their abilities. They figure that by paying attention to the little things—Clay, for example, carefully recoiling an impact wrench air hose after a pit stop—the big ones will take care of themselves.

An insight as to how and why the Wood Brothers tick was overheard just before the start of a Grand National race last fall. As the cars were lined up to start their parade lap, a member of a rival crew leaned over to holler in Glen's ear, "Now when we lap y'all out there this afternoon, we want you to get your rump out of the way."

Glen eyed the man levelly, then said in a voice barely audible above the roar of the poised race cars, "You'll have to catch us first." ★ ★ ★

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CONNECTICUT SHELF CLOCK

(Continued from page 153)

but not into the case. Use only one screw in each leaf for a trial fit. Then you can make an adjustment, if necessary.

Fasten the glass in the upper section of the door temporarily with a couple of brads. Then cut 3 and 6-in. squares of $\frac{1}{8}$ -in. hardboard. Locate the holes for the hand shaft and key stem in the 6-in. piece by using the dial plate as a pattern. Now center the 3-in. square and glue it to the rear face of the 6-in. square. This double thickness is needed since the threaded bushings supplied with most movements are designed for $\frac{1}{4}$ -in. panels.

For best visibility, the clock hands should be located as close as possible to the glass. Here is how I located the movement:

First I fastened the movement to the 6-in. square and measured the projection of the minute-hand shaft. Then I added $\frac{3}{32}$ in. to the dimension, closed the door and measured in to locate the support cleats which are attached to each side of the case. I fastened the cleats only temporarily, placed the movement in position with the case on its back and checked the clearance between the glass and the shaft. Finally I removed the cleats, applied glue and fastened them permanently.

I used a magnetic catch to hold the door shut, after stripping off the metal frame and using just the magnet and the two pole plates.

If you'd like to finish your clock as I did, brush on pigmented wiping stain, a 50/50 mixture of walnut and French provincial. Let stand until it starts to flatten, then wipe with a cloth. Let dry 24 hours. Next apply a coat of color glaze (Martin Senour sable No. 457). Wipe off with a cloth, leaving traces in the corners, nicks and scratches. Let dry 24 to 48 hours. Follow with two coats of sanding sealer, letting them dry an hour or so between coats. Now sand *lightly* with 6/0 garnet paper and dust thoroughly. Next brush on four coats of lacquer, allowing 30 minutes between coats. Let dry 24 hours.

Wet-sand with soapy water and No. 400 wet-or-dry paper on a felt or rubber block. Use light pressure and inspect the surface frequently by wiping. Stop sanding when the surface has an even satin finish and clean up with a dry cloth.

Fasten the dial backing plate to the support cleats with $\frac{1}{2}$ -in. No. 4 flathead screws, drop the dial plate into position and install the movement with the bushings furnished. Always remember to remove the pendulum before moving the clock.

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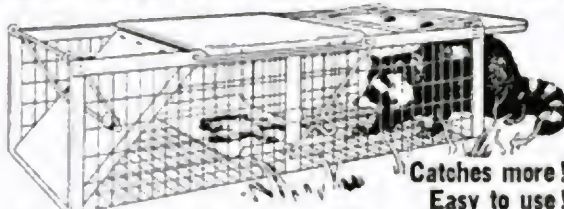
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PISTON ENGINE

(Continued from page 99)

range of speed and load. For high speed, you want to keep the valves open longer. But this hurts the power and response at low speeds. A low-speed engine has very short valve "duration." For years auto engineers have been looking for some way to vary the valve timing automatically while the engine is running.

Various tricks have been tried. One has the camshaft on a special hub that swivels in relation to the crankshaft, so that the valves close later and later as the speed goes up. You get more power at the top end and more low-speed torque at the same time. We fully expect to see something like this offered as an option on some Detroit models within five years.

● **Crankcase Oil Churning Loss.** When your crankcase and connecting rods spin at high speed in the crankcase, they generate tremendous air turbulence that churns and whips the oil in the oil pan. Engineers call this crankcase "windage." And the friction and churning loses horsepower—like 10 or 15 at 5000 rpm on a big engine. This is wasted power that can be recovered with a simple stamped steel pan, or baffle, that goes between the spinning crankshaft and the oil in the crankcase. The pan is slotted so the oil can run back, but can't splash up on the crankcase. It costs less than \$1 and saves 10 to 15 hp. All Detroit engines will have them soon.

● **Cooling-Fan Loss at High Speed.** The fan on the front of your engine can absorb up to 15 hp at high speeds. And yet the only time it's really needed is to pull air through the radiator when idling and at very low car speeds. The rest of the time it's just wasting power. We have the answer today in these new "declutching" fans that are being supplied as standard equipment on many high-performance engines. They have a simple fluid-drive hub that is designed to slip when the fan gets up to some medium speed (maybe around 2000 rpm). They cost extra money, but we expect to see them on all cars soon, especially with the increasing use of air-conditioning and exhaust-emission controls that throw more load on the cooling system. Tomorrow's cars will need bigger radiators and bigger fans. But the fans will still be a waste at high speed. Detroit has got to solve this one.

These are just a few of the problems with the piston engine and some of today's and tomorrow's solutions. There are other problems in areas of engine life, reliability, maintenance, engine weight, cost and performance. But lots of potential is what the piston engine's got today. ★★

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ARMY'S SUPERSECRET SCOPE

(Continued from page 82)

50 times, and amplification of one tube is multiplied by that of the others to give a picture approximately 50,000 times brighter than the scene itself.

"It's not possible to get 100 percent efficiency," Klein points out. "We lose light in transferring the image from one tube to the other. However, the brightness we do get is more than enough for troops to see."

One of the biggest problems faced in development of the Starlight Scope was to find a way of transferring the image from one tube to the next without losing too much image resolution. It was at this point in development that the Allied armies interrupted the work of the German scientists.

They had been experimenting with pieces of phosphor-coated glass .0003 inch in thickness. However, the image lost too much resolution, and the thin glass made the device too fragile.

The answer to the problem was fiber optics, the invention of Dr. A. C. S. Van Heel, of the University of Delft, in the Netherlands in 1948. Each fiber-optic lens consists of two million tiny hexagon-shaped light pipes which direct the amplified picture from the phosphor coating of one tube to the photo cathode of the other.

The uniqueness of fiber optics lies in its ability to transfer light without diffusion. In Starlight Scope, light from a particular spot on the phosphor of one tube falls in the same spot on the photo cathode of the next tube.

By comparison, conventional glass lenses would cause too much diffusion and, consequently, too much loss of light. When you're using available nighttime light to see by, any loss of that light is critical.

Each fiber optic lens (there are six to a scope—two for each tube) is carefully curved to permit every electron to travel the same distance. This gives a perfectly focused image.

The electrical system of Starlight Scope begins with a small 1.7-volt mercury battery. An oscillator steps up voltage to 2500 volts a.c., which is fed into a voltage multiplier. The result is 45,000 volts d.c.—15,000 for each tube.

An irksome problem regarding this current was to find a way of protecting the user in case of an insulation failure. "After all, a man's putting 45,000 volts to his eye," Klein states.

The eyepiece of the scope was shaped into a series of convolution rings which, if the scope did leak, would allow a long leakage path, making a shock insignificant.

There are now three versions of Star-

light Scope. The small scope is mounted on a man's rifle as a gunsight. It has a maximum range of about 450 yards and weighs 5¾ pounds.

A larger-sized scope is used on crew-served weapons, such as machine guns and recoilless rifles. Weighing 16 pounds, it has a maximum range of about 1100 yards.

The big scope, called NOD (Night Observation Device), is used by night observation teams. It's mounted on a tripod, weighs 38 pounds and has a maximum range of about 1300 yards.

The Army spent \$20 million developing Starlight Scope. Was it worth it? Only the guys who have used it in combat can tell.

On one occasion, for example, an infantry night patrol of 15 men detected a company-sized Vietcong force moving toward them. The scope had sighted them.

As the Americans prepared to open fire, the patrol leader, Lt. Robert Hibbs, of Cedar Falls, Iowa, spotted another VC force through his Starlight Scope.

Hibbs let the first unit pass, placed his patrol between the two and opened fire on the second. Each enemy unit, thinking it was being attacked by Americans, opened fire as the U.S. patrol withdrew. They blasted one another. Hibbs, killed during the withdrawal, was awarded the Congressional Medal of Honor.

In another action, an American aircraft gunship equipped with a Starlight Scope spotted 200 Vietcong in a rice paddy preparing to attack a village. The gunship zeroed in and opened fire. This stopped the attack before it got started.

Because of the tremendous tactical advantage offered an army that has passive image intensifiers, the question remains as to how long it will be before the Vietcong and North Vietnamese develop theirs. They have captured some of ours.

"It's unlikely that the VC or North Vietnamese have the degree of technical sophistication needed to make a device like Starlight Scope," says Dr. Robert S. Wiseman, head of the Night Vision Lab.

A most important and difficult operation in the production of the scope, for example, is to get a vacuum-tight fit when the three intensifier tube segments are butted together. Less than a perfect seal would allow air leaks and lead to unrestricted movement of electrons. How this aspect of the production operation is performed is still a secret.

But what about the Chinese and Russians—can they develop something like Starlight Scope?

"We must assume that the former can develop passive image intensification if they desire, and that the latter may already have it," Wiseman states. ★★

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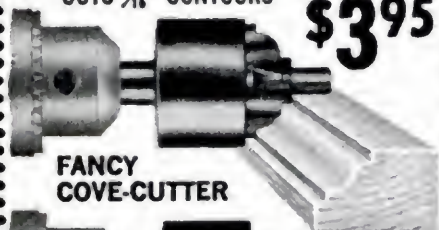
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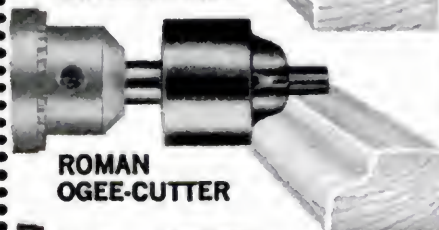
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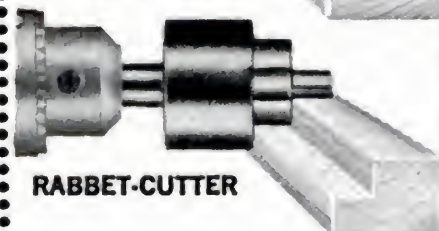
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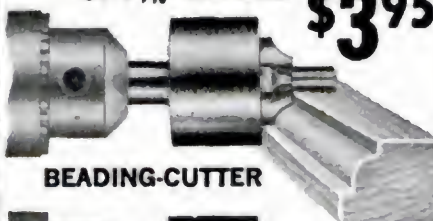


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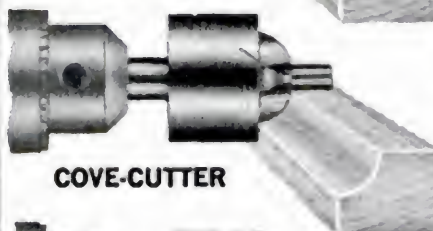
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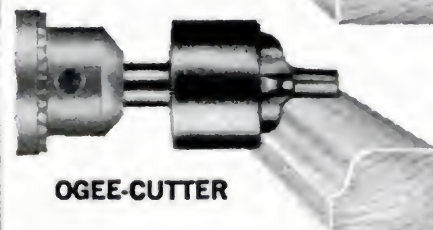
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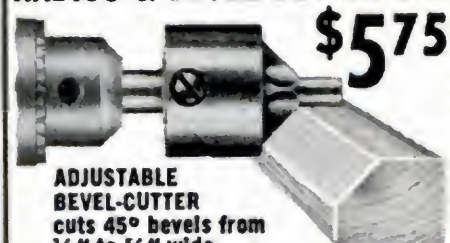
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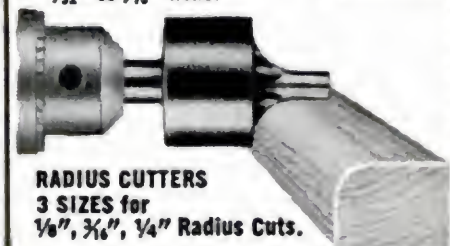
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WHEN SOLDERING with either a propane torch or a conventional soldering iron, it's often desirable to keep the molten solder from running on to the adjacent work surface. In such cases, I've discovered I can "mask" these areas by using a paste made of lampblack—a very black powder sold at most hardware and paint stores for 20 to 25 cents a pound. It's normally used for darkening concrete or paint, but I've found that it does a great job of repelling the molten solder and protecting adjacent surfaces.

To prepare a mixture properly, first clean an empty shoe-polish can (of the easy-open key type), then spoon in lampblack until the can is half full. Slowly mix in a half spoon or so of kerosene, thoroughly blending it with the powder. If necessary, add a few more drops of kerosene and continue mixing until the paste has a very fine and thin consistency.

Don't try to use water as the mixing agent, for the lampblack rejects the water and you wind up with an unmanageable mess. (Other solvents may do the job, but kerosene is usually available and it won't evaporate as quickly.)

To use the thin paste, first clean the joint with a wire brush or steel wool, then use a small artist's paintbrush to apply the lampblack mixture to the surfaces you want to protect. Then you can solder as usual, for the heat of the iron will dry the mixture and leave a fine masking coat to which molten solder won't stick.

After the work has cooled, wipe or wash the joint to remove the masking film and reveal a well-controlled soldering job. Tightly cover the can containing the remaining mixture, and the next time you have a soldering job that requires delicate masking, just open the can and brush on the paste.—Andrew Vena

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